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Cover: Arctic hares (*Lepus arcticus monstabilis*) photographed by Gerald R. Parker on 5 August 1973 at Mokka Fiord, Axel Heiberg Island, Northwest Territories. See article on page 8.

The Canadian Field-Naturalist

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January-March 1977

Distribution and Abundance of Waterfowl Wintering in Southern Quebec

AUSTIN REED and ANDRÉ BOURGET

Canadian Wildlife Service, Environment Canada, P.O. Box 10 100, Ste-Foy, Quebec G1V 4H5

Reed, Austin and André Bourget. 1977. Distribution and abundance of waterfowl wintering in southern Quebec. Canadian Field-Naturalist 91(1): 1-7.

Abstract. In January and February of 1974, 1975, and 1976, surveys of wintering waterfowl were conducted through most open-water areas of southern Quebec. These surveys indicated the presence of at least 171 000 ducks, mostly diving and sea ducks in the estuary and Gulf of St. Lawrence. Inland freshwater areas, mainly in the Montreal region, supported many Common Goldeneye (*Bucephala clangula*), Common Merganser (*Mergus merganser*), and Black Duck (*Anas rubripes*). The most abundant ducks on the estuarine portion were Oldsquaw (*Clangula hyemalis*), Common and Barrow's (*Bucephala islandica*) Goldeneyes, and Black Duck. In the gulf, Common Eider (*Somateria mollissima*), Oldsquaw, Common and Barrow's Goldeneyes were abundant. The area of the estuary and gulf is of international importance as a sea- and diving-duck wintering ground. Further study and close surveillance are required owing to the birds' apparently great vulnerability to oil pollution and habitat change in a very rigorous climate.

Résumé. Aux mois de janvier et février 1974, 1975 et 1976, des inventaires de sauvagine ont été effectués dans la partie sud de la province de Québec. Au moins 171 000 canards, représentés principalement par des canards de mer et des canards plongeurs ont séjourné durant l'hiver dans l'estuaire et le golfe du Saint-Laurent. Dans les eaux douces de l'intérieur, surtout dans la région de Montréal, on a recensé bon nombre de Garrots communs (*Bucephala clangula*), de Bec-scies communs (*Mergus merganser*) et de Canards noirs (*Anas rubripes*). Dans l'estuaire, les espèces observées en plus grand nombre furent le Canard kakawi (*Clangula hyemalis*), le Garrot commun, le Garrot de Barrow (*Bucephala islandica*) et le Canard noir. Dans le golfe, l'Eider commun (*Somateria mollissima*), le Canard kakawi, le Garrot commun et le Garrot de Barrow étaient présents en abondance. Nos données prouvent que les régions de l'estuaire et du golfe sont parmi les quartiers d'hiver les plus importants du monde, surtout en ce qui concerne les canards de mer et certains canards plongeurs. Il serait souhaitable que l'on poursuive des études et qu'on exerce une surveillance étroite sur les populations hivernantes de sauvagine à cause de leur grande vulnérabilité à la pollution par l'huile et en raison des changements qui surviennent dans un habitat en climat très rigoureux.

Several species of water birds overwinter in southern Quebec, principally along the St. Lawrence river, estuary, and gulf. Heavy ship traffic during the winter and expanding urban and industrial development along the shores are posing an ever increasing threat to those birds and to their habitats. The paucity of published information prompted us to assemble recent unpublished reports and to conduct surveys to document the distribution and abundance of waterfowl inhabiting that area during the winter.

Study Area and Methods

In early February 1974, 1975, and 1976, we attempted to cover all open-water areas in

southern Quebec by ground and/or aerial counts.

Regional differences in accessibility, habitat type, and species composition prevented the use of a standard survey procedure for the entire study area. We subdivided the area into 10 zones based on these regional differences (Figure 1).

The 1974 survey was carried out from 31 January to 20 February, in 1975 from 3 to 6 February, and in 1976 from 1 to 12 February. Ground crews (P. Blais, A. Bourget, H. Briard, G. Chapdelaine, P. Dupuis, G. Fortin, P. Lamothe, M. Laverdière, D. Lehoux, P. Rancourt, A. Reed, L.-G. de Repentigny, J. Rosa, J.-P. Savard, and G. Tremblay)

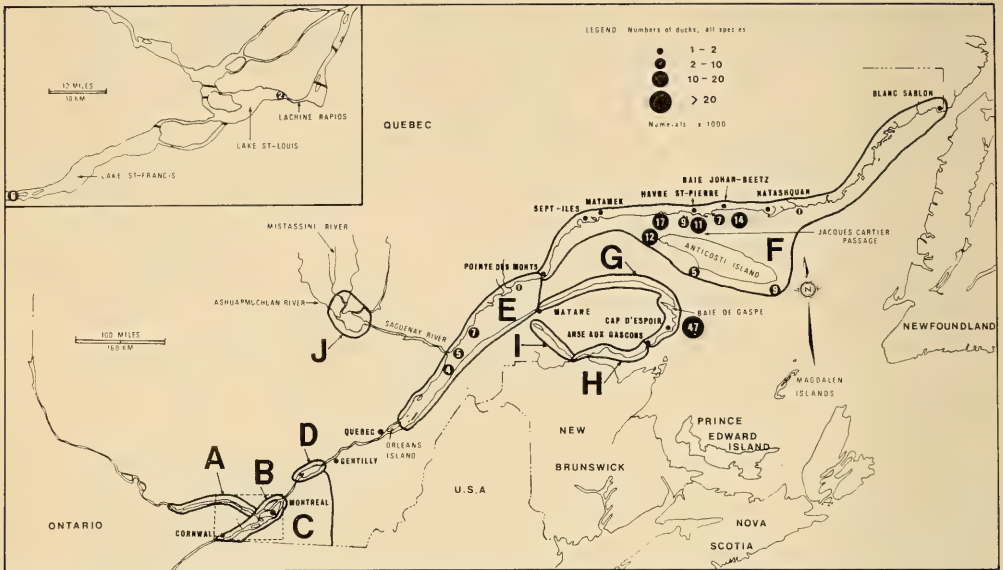


FIGURE 1. Southern Quebec, showing major duck wintering sites (dark circles) and survey zones (outlined and identified by large letters). The Montreal area is shown in a larger scale on the inset at the upper left of the figure. The survey zones are (A) Ottawa River, (B) Montreal, (C) Eastern Townships, (D) Lake St. Peter, (E) St. Lawrence estuary, (F) North shore, Gulf of St. Lawrence, (G) Gaspésie, (H) Baie des Chaleurs, (I) Matapédia, (J) Lake St. John.

methodically scanned all open-water areas with telescopes and binoculars in all zones except part of zone F. Dupuis and Tremblay conducted aerial surveys that covered mainly zones E and F. In most flights a Cessna 337 was flown at an altitude of approximately 60 m parallel to, and about 70 m seaward from, the edge of the shoreline of permanent ice. At some coastal sites flights were conducted up to 15 km from shore to check for offshore flocks of sea ducks.

Supplementary observations were available from previous years for the Montreal area and the north shore of the estuary, mainly since 1964. Files of the Canadian Wildlife Service and the Quebec Wildlife Service yielded unpublished results of various winter surveys conducted from 1952 to 1963, mainly in the Montreal area. The winter season was considered to extend from 1 January to 28 February.

Results

The combined results of the 1974, 1975, and 1976 surveys are presented in Table 1 and Figure 1. We believe that we consistently under-

estimated the bird populations because (1) exhaustive surveys were not possible over such a vast and partly inaccessible area, (2) many of the species inhabited offshore areas and were difficult to detect from aircraft (see Stotts and Olson 1972), and (3) cold air temperatures and ice conditions reduced the efficiency of the observers. For these reasons, the largest number of birds recorded in each zone over the three winters can be considered as the best estimate of that population; we have presented those maximum counts in Table 1. The data, in summarized form, are plotted in Figure 1 to show major concentration areas. Those results, and previous data, form the basis for the description which follows for each area.

(A) Ottawa River

Most of this area was frozen over in winter; only a few natural pools and areas below a hydroelectric dam remained open. In 1974 (no counts in 1975-76) three species of ducks occurred but only in small groups: Black Ducks (*Anas rubripes*), Common Goldeneyes (*Buce-*

TABLE 1—Estimated numbers of aquatic birds that overwinter in the St. Lawrence River system, Quebec. Each number represents the maximum count obtained. Surveys were conducted in most regions in February 1974, 1975, and 1976

Species	Regions									Total
	Ottawa River	Montreal	Eastern Townships	Estuary	North shore	Gaspésie	Baie des Chaleurs	Matapédia River	Lake St. John	
Black Duck (<i>Anas ribripes</i>)	56	506	71	1906				4		2543
Common Goldeneye (<i>Bucephala clangula</i>)	160	2908	164	8328 ¹	979 ¹	332	111	12	8	13002
Barrow's Goldeneye (<i>Bucephala islandica</i>)	1		4	1394	869	260	19			2547
Bufflehead (<i>Bucephala albeola</i>)		1	2	69		1				73
Oldsquaw (<i>Clangula hyemalis</i>)				6451	2411	46782	48			55692
Surf Scoter (<i>Melanitta perspicillata</i>)					185					185
Common Eider (<i>Somateria mollissima</i>)				9	91035	505				91549
Common Merganser (<i>Mergus merganser</i>)	16	5300	196	19		5	5	7	2	5550
Red-breasted Merganser (<i>Mergus serrator</i>)			2	91	74	98	23	1		289
Miscellaneous duck species ²	1	72	12	3	1					89
Sub total — Ducks	234	8787	451	18270	95554	47983	206	24	10	171519
Great Cormorant (<i>Phalacrocorax carbo</i>)						21	91			112
Black Guillemot (<i>Cephus grylle</i>)				78		57	42			177
Total	234	8787	451	18348	95554	48061	339	24	10	171808

¹May include some *B. islandica*.²Miscellaneous duck species by order of importance are as follows: Ottawa River, Mallard (*Anas platyrhynchos*); Montreal, Mallard, Pintail (*Anas acuta*), Canvas-back (*Aythya valisineria*), Redhead (*Aythya americana*), Lesser Scaup (*Aythya affinis*), Ring-necked Duck (*Aythya collaris*), American Wigeon (*Anas americana*); Eastern Townships, Mallard, Hooded Merganser (*Lophodytes cucullatus*); Estuary, Harlequin Duck (*Histrionicus histrionicus*), Mallard; North Shore, Black Scoter (*Melanitta nigra*).

phala clangula), and Common Mergansers (*Mergus merganser*).

(B) Montreal

This region had large areas of open water, principally at the inlets and outlets of its two largest bodies of water, Lake St. Francis and Lake St. Louis. The Lachine rapids were particularly important. The Montreal region possessed the most important winter-bird concentrations in freshwater areas in Quebec. The

Common Merganser was the most abundant species in the Montreal region; more than 3500 birds spent the winters of 1974 and 1975 in open water below the Cornwall hydroelectric dam, feeding on fish which had passed through the turbines. The Common Goldeneye was second in importance and the Black Duck third.

(C) Eastern Townships

All areas south of Lake St. Peter and east of Montreal were included in this zone.

Open-water areas were found along fast-flowing streams and rivers in this rolling countryside. In contrast to the ice-free areas of the St. Lawrence, which were relatively consistent in size and location from year to year, open water was highly variable in extent and location within and between winters. No large concentrations of ducks were encountered. Common Mergansers, Common Goldeneyes, and Black Ducks occurred regularly.

(D) *Lake St. Peter*

This zone had no appreciable areas of permanent open water and no waterfowl were observed.

(E) *Estuary*

This portion of the St. Lawrence had large expanses of open water throughout the winter. Of particular importance were large sections of tidal flats near the mouth of the Saguenay River where tides and river currents prevented the formation of permanent ice. Along most of the south shore, water areas suitable for aquatic bird use were frozen over.

This vast area included some of the most important wintering sites for waterfowl in the province, especially along the north shore of the St. Lawrence. The most important concentration of wintering Black Ducks in Quebec was found on the tidal flats near the mouth of the Saguenay River, where more than 75% of the Black Ducks counted in 1974 were found. The Common Goldeneye was the most widely distributed duck on the north shore of the estuary and was the most abundant species. The Oldsquaw (*Clangula hyemalis*) was also important but it was difficult to appraise its distribution and abundance because it often frequented areas too far from shore to be seen by ground crews and because it took flight early and dispersed rapidly at the approach of an aircraft; it was undoubtedly more abundant than our figures indicated. The Barrow's Goldeneye (*Bucephala islandica*) was also encountered frequently. Buffleheads (*Bucephala albeola*) occurred regularly (although in small numbers) only near the mouth of the Saguenay River. Two other species of aquatic birds also occurred regularly: the Red-breasted Merganser (*Mergus serrator*) and the Black Guillemot (*Cepphus grylle*).

(F) *North Shore of the Gulf*

This region extends from Pointe des Monts to Blanc Sablon on the Quebec-Labrador border (about 800 km) and includes Anticosti Island. Because of the vastness of the area and inaccessibility of certain portions, its coverage cannot be considered exhaustive. The inner part from Pointe des Monts to Matamek was surveyed both from the ground and from the air; east of Matamek was surveyed only from an aircraft. Ice conditions are generally heavy in this region although the area of Natashquan and the eastern tip of Anticosti Island is characterized by less severe conditions (Simpson 1973).

Sea ducks represented the most important component of the wintering population of aquatic birds. The Common Eider (*Somateria mollissima*) was recorded along the outer north shore of the gulf; most birds of this species were seen in the Jacques-Cartier passage in areas of slushy ice. The Oldsquaw and Goldeneyes (Common and Barrow's combined) were also abundant.

(G) *Gaspésie*

Ice conditions in this zone were highly variable. Water areas were completely covered by large sheets of floating ice when inshore winds prevailed. The eastern tip of the peninsula, however, was more consistently ice-free; most large flocks were observed there.

The Oldsquaw was by far the most abundant bird species observed in 1974 and 1976; most birds of this species were in Baie de Gaspé, which was clear of ice. In 1975, that site was choked with ice and only a small number of Oldsquaws was observed in the entire zone. Similarly, our counts of goldeneye (Common and Barrow's) varied from year to year, apparently reflecting different conditions of ice cover.

(H) *Baie des Chaleurs*

This large bay was characterized by heavy ice conditions (Simpson 1973), but occasionally strong west winds opened up large expanses of the bay. Despite different ice conditions (1974 heavy, 1975 and 1976 light) few birds were observed. Common and Barrow's Goldeneyes, Oldsquaw, Red-breasted (*Mergus serrator*) and Common Mergansers, and Great

Cormorants (*Phalacrocorax carbo*) were encountered regularly in all years.

(I) *Matapedia*

Many sections of the river remained open through the winter, but were not heavily used by wintering waterfowl. The Common Goldeneye was the main species encountered.

(J) *Lake St. John*

The only open-water areas in this zone were found on fast-flowing sections of rivers, principally the Ashuapmucuan and the Mistassini which flow into the lake. Very few birds were present in this area in 1974 (no census in 1975 and 1976). Common Goldeneyes and Common Mergansers were the only species observed.

Discussion

The abundance and diversity of the wintering population is remarkable for an area with such a harsh and rigorous climate. In winter waterfowl require open water that can offer an abundant food supply and suitable resting areas (Nilsson 1972). Several species can be accommodated in southern Quebec because there is a wide variety of habitats, ranging from inland-freshwater to coastal-saltwater, which are kept open by tides, winds, and currents. Food is available in the form of aquatic organisms, which are notably abundant in intertidal and sub-littoral zones in the St. Lawrence estuary and gulf.

Of the nine species of waterfowl which wintered regularly in this region the Common Eider, the Oldsquaw, and the Common Goldeneye were, in that order, the most numerous. Large flocks of eiders were present in saltwater along the north shore of the gulf, particularly off Natashquan, Baie Johan-Beetz, Havre St-Pierre, and around Anticosti Island. Flocks of several thousand Oldsquaw were found in salt and brackish waters in Baie de Gaspé, the estuary, and along the north shore of the gulf. Common Goldeneyes occurred in fresh, brackish, and saltwater habitats, the largest concentrations being located in the vicinity of the mouth of the Saguenay River (north shore of the estuary) and in the Lachine Rapids near Montreal.

The great abundance of Common Goldeneye

and Oldsquaw in the estuary and gulf was heretofore unrecognized (Bellrose 1976; Johnsgard 1975). Similarly, Barrow's Goldeneye was believed to be relatively rare on the east coast of North America (Bellrose 1976; Johnsgard 1975; Palmer 1976; Hasbrouck 1944); our data indicate that the St. Lawrence estuary and gulf represent a stronghold of an unexpectedly large population.

Our counts in January and February (1974-1976) indicated an annual wintering population of about 171 000 ducks, despite incomplete coverage. Clearly our eider estimates must be very low owing to the inaccessibility of many of the known or suspected haunts of this bird; the same applies to the Oldsquaw, with the added complication of its known ability to escape detection by aerial observers (Stotts and Olson 1972). The estimates of goldeneye from coastal areas are undoubtedly low as well. Although precise adjustments cannot be made at this time, it seems likely that the area covered must harbor at least a quarter of a million ducks and it is conceivable that half a million could be involved.

Clearly the most important part of the study area was the estuary and gulf of St. Lawrence (Zones E, F, G, and H), which accounted for 94% of the ducks recorded. Some areas of the gulf which were not covered by this study also support important populations of wintering ducks. Average winter populations (1972-1974) on Prince Edward Island were 3070 Black Ducks, 1540 goldeneye (apparently almost all *B. clangula*), 1450 mergansers (species not indicated), and small numbers of Oldsquaw (Batesman, M. 1974. Mid-winter aerial waterfowl surveys of the Maritime Provinces. Unpublished report, Canadian Wildlife Service, Sackville, N.B. mimeo. 13 pp.). The Magdalen Islands support a few hundred Oldsquaw (A. Smith, personal communication), while Newfoundland is an important gathering area for Common Eiders (Gillespie and Learning 1974). Unfortunately there are too many gaps in the data to allow estimation of the winter duck population of the entire gulf.

Other areas along the Atlantic coast of North America are also important wintering areas. Various data from aerial surveys in Nova Scotia,

New Brunswick (Bateman, *loc. cit.*) and the Atlantic Flyway (winter surveys coordinated by the United States Fish and Wildlife Service) for selected species are presented in Table 2 along with comparative data from the present study. Although those more southerly areas harbor large numbers of surface-feeding ducks it is evident that the St. Lawrence is of great importance to sea and diving ducks.

Comparison with European counts is more difficult because a more complete coverage is obtained there by using a network of ground observers (Atkinson-Willes 1969). In terms of total ducks present, however, few areas of equivalent size harbor as many ducks as the St. Lawrence. For example, a comparison of our figures with those from the Baltic Sea, indicated by Atkinson-Willes (1969, Figure 2, p. 105), suggest wintering duck populations of similar magnitude. Also, much of the North Sea has fewer ducks than does the St. Lawrence (Atkinson-Willes 1969; Milne and Campbell 1973). That area of the North Sea encompassing Denmark, the Netherlands and northern Germany, however, has a much larger overwintering duck population. The latter area is probably the only European site of greater importance than the St. Lawrence to diving and sea ducks (Atkinson-Willes 1969; Joensen 1974). Clearly the St. Lawrence must be considered one of the major duck wintering areas of the North Atlantic.

Industrial and urban development along the St. Lawrence pose a constant threat to the birds and to their habitats. Port facilities for super-tankers have been proposed for the estuary and gulf, which would increase the likelihood and gravity of oil spills which could have disastrous effects. In the past two years, 102 cases of oil pollution have been reported in these regions; it is only through good luck that none has had serious effects. In the Lachine Rapids near Montreal, a hydroelectric dam has been proposed which, through major changes in the hydrography and biology of the area, could lead to drastic reduction in the Common Goldeneye population. Some habitat changes may lead to an increase in the numbers of some species. The proposed Lachine Rapids dam might increase the numbers of Common Mergansers, as has occurred further upriver near Cornwall. The Lake St. Peter area, which presently has no open water, may eventually serve as a new wintering ground if warm water effluents from nearby nuclear power plants at Gentilly prevent the freezing over of expanses of the St. Lawrence in that area.

This investigation has permitted the identification of the more important areas of the system and provided an approximate estimate of numbers of the various species of wintering birds, but further work is required. In particular, the surveys along the remote outer north shore cannot be considered as exhaustive.

TABLE 2—Summary of counts of selected species of wintering ducks on the Atlantic coast of North America

Species	St. Lawrence ¹	Nova Scotia and New Brunswick ²	United States ³
Black Duck (<i>Anas rubripes</i>)	2500	11800	304500
Common Goldeneye (<i>Bucephala clangula</i>)	13000	4400	68200
Oldsquaw (<i>Clangula hyemalis</i>)	55700	850	12200
Common Eider (<i>Somateria mollissima</i>)	91500	2100	72600

¹This study, based on maximum of mid-winter counts 1974–1976 (from Table 1, rounded to nearest 100).

²Bateman (1974)—Jan. and Feb. 1974 (Atlantic and Fundy coasts).

³Unpublished results of mid-winter waterfowl surveys in the Atlantic Flyway, coordinated by the United States Fish and Wildlife Service. Average 1964–1973.

Further work is proposed to obtain more accurate counts of sea ducks in the estuary and gulf, to document further the present status of the Barrow's Goldeneye in winter, and to clarify the racial status of Common Eiders (two races, *Somateria mollissima dresseri* and *S. m. borealis*, are known to overwinter in the gulf (Ouellet 1969, 1975; Gillespie and Learning 1974)). Also it is hoped that a survey can soon be undertaken to cover the entire gulf. The continued and increasing threats from industrial and urban development provide ample justification for close surveillance and further study.

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Morphology, Reproduction, Diet, and Behavior of the Arctic Hare (*Lepus arcticus monstrabilis*) on Axel Heiberg Island, Northwest Territories

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Parker, Gerald R. 1977. Morphology, reproduction, diet, and behavior of the arctic hare (*Lepus arcticus monstrabilis*) on Axel Heiberg Island, Northwest Territories. *Canadian Field-Naturalist* 91(1): 8-18.

Abstract. Fifty-one arctic hares (*Lepus arcticus monstrabilis*) were collected at Mokka Fiord, Axel Heiberg Island, Northwest Territories: 35 in summer 1973 and 16 in late winter 1975. Adult female weights averaged 4.5 and 3.9 kg for the summer and winter periods respectively; male weights, 4.1 and 4.0 kg. There were significant decreases in the weights of the heart and kidneys between summer and winter samples, as well as an overall loss in body weight. In 1973 the peak of births was believed to have been approximately 20 June. The average litter size, as determined from counts of corpora lutea was approximately five. Breeding occurred about 1 May; the period of gestation was approximately 50 days. Arctic hares displayed great diversity in their summer diet, but fed mainly on arctic willow (*Salix arctica*), *Dryas integrifolia*, and grasses. Arctic willow was the main species consumed at all seasons, and made up 95% by weight of the winter diet. The abundance of willow, a light covering of winter snow, and broken terrain providing adequate escape cover may explain the high densities of arctic hares on parts of Axel Heiberg and Ellesmere Islands.

The arctic hare (*Lepus arcticus*) is found in Canada north of the treeline to the northernmost point of land on Ellesmere Island, Northwest Territories, and also on the rock-strewn plateaus and mountains of eastern Newfoundland. In Greenland it is common on most of the ice-free coastal region.

In North America studies of *L. arcticus* have been limited to short notes on their distribution (Bergerud 1967; J. G. Inder. 1972. Arctic hares on Brunette Island. Typewritten report to Newfoundland Wildlife Service, 3 pp.; Watson 1954), taxonomy (Handley 1952; Howell 1936; Nelson 1934), predation (Tener 1954), and natural history (Walkinshaw 1947). Bonnyman (1975) made observations on the behavior and habitat use of hares on the Fosheim Peninsula, Ellesmere Island in the summer of 1975, but detailed information on the biology of the arctic hare is absent from the literature. Arctic hares occur in unusually high densities and often form herds of several hundred or more individuals on parts of Ellesmere and Axel Heiberg Islands. In the summer of 1973 I observed and collected specimens of *L. arcticus monstrabilis* during a study on the feeding habits of muskoxen (*Ovibos moschatus*) and caribou (*Rangifer tarandus pearyi*) at Mokka Fiord, Axel Heiberg Island,

and returned to Mokka Fiord in late winter 1975 for further observations and collections.

Study Area

Mokka Fiord is close to the northern limit of arctic hare range (Figure 1). The study area is a valley 6 to 12 km wide; a mountain range is to the west and a lower series of gypsum piercement domes on the east drop abruptly to the waters of Mokka Fiord and Eureka Sound. The valley floor is approximately 200 m above sea-level. The gypsum domes present a region of sparsely vegetated gravel- and rock-strewn ridges and slopes, giving way to an interspersed of gravel ridges and meadows in the valley proper. Meadows are restricted to the glacier-fed streams originating in the mountains to the west.

The slopes west of the valley support *Salix arctica*, *Luzula nivalis*, *Poa* spp., *Alopecurus alpinus*, *Arctagrostis latifolia*, *Dryas integrifolia*, *Saxifraga* spp., and a variety of other forbs. The gravel ridges in the valley support a wide variety of forbs and several grasses; *Carex stans*, *Eriophorum* spp., and mosses dominate the meadows. The gravel- and rock-strewn slopes east of the valley support only occasional tufts of grasses (*Poa* spp., *Puccinellia* spp.), *Carex rupestris*, *Kobresia myosuroides*, and

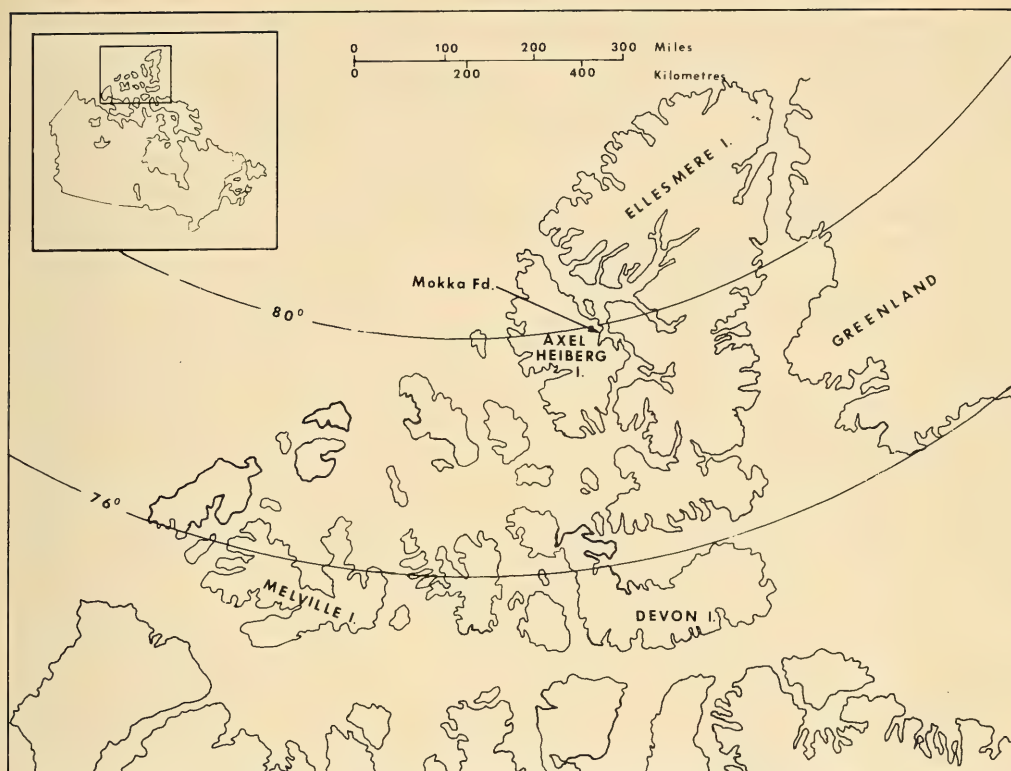


FIGURE 1. The location of Mokka Fiord, Axel Heiberg Island, Northwest Territories.

scattered mats of *Salix arctica*. Occasional forbs include *Papaver radiculatum*, *Oxyria digyna*, *Saxifraga oppositifolia*, and *Dryas integrifolia*. Lichens are common but not abundant, the dominant species being *Cetraria nivalis*, *C. cucullata*, *Thamnolia vermicularis*, and *Parmelia* spp.

The mountains of Axel Heiberg Island and eastern Ellesmere Island present a barrier to moist air from the south. This topographical peculiarity contributes to less cloud cover and higher temperatures in summer on western Ellesmere and eastern Axel Heiberg Islands than in most of the Arctic. At Eureka on northwestern Ellesmere Island, mean annual snowfall is 37.5 cm and total precipitation only 6.8 cm (Thompson 1967). Mean daily winter temperatures are among the coldest in the Canadian Arctic; the average for November to March is -26.9°C .

Methods

Hares were collected from 3 July to 3 August 1973 and from 23 March to 6 May 1975. They were shot at close range (5 to 20 m) with a .22-caliber rifle. Most specimens were shot in the neck to avoid damage to the skull or internal organs. Each specimen was weighed on spring scales and standard body measurements were taken (Anderson 1965). The heart, lungs, full stomach, liver, and kidneys were weighed on a beam balance. Stomach samples were preserved in an alcohol-formalin-acetic acid solution (AFA) for future analysis. Reproductive tracts were also preserved in AFA. The skulls and mandibles were retained, and a small collection of skins was made from the 1975 collection. All material was deposited with the Canadian Wildlife Service, Atlantic Region, Sackville, New Brunswick. General observations on hare behavior were recorded whenever possible.

In the laboratory, basic cranial and mandibular measurements were taken for each specimen, the specifications conforming with those by Banfield (1961) for caribou. Ovaries were sectioned for a count of corpora lutea. Ovaries were dehydrated and embedded in paraffin, and by use of a rotary microtome, were sectioned in units of $10\ \mu$ thick. Every tenth section was mounted on a slide and stained with Weigert's haematoxylin. External measurements of each ovary were taken in addition to the maximum length, breadth, and depth (number of sections in which structure appears $\times 10\ \mu$) of each corpus luteum.

Differences between measurements for components of the sample were tested for significance using a simple *t*-test.

The diet of hares was determined by the identification of plant epidermal tissue in stomach samples. The preparation of plant reference slides and key and the method of stomach sample analysis is described by Parker et al. (Parker, G. R., B. Campbell, and M. Gauthier. 1976. Estimating the diet of Arctic herbivores by rumen and faecal analysis. Canadian Wildlife Service Report CWSC-2021. Ottawa. 143 pp.).

In contrast to the herbaceous-dominated summer stomach samples, the winter diet contained a large amount of unidentifiable woody material. As the only woody plant of any consequence is the arctic willow, most of the woody component of the diet was assumed to be that species. Twigs of *Dryas integrifolia* and the roots of forbs may also have comprised an unknown portion of the non-herbaceous diet.

To quantify the importance of herbaceous and

woody forage in the winter diet, a wet sample of 15 to 20 g was washed through a series of sieves of the following dimensions: 1.18 mm; 850 μ ; 425 μ ; and 300 μ . Samples of material from each sieve were examined for presence of herbaceous material. Only the sieve of 300 μ contained appreciable amounts of herbaceous material; the others contained woody fragments almost exclusively. Contents of the 300- μ sieve were then analyzed for plant species composition similar to the summer samples. The weights of material in all sieves were totalled and divided into the weight of herbaceous material in the 300- μ sieve. The latter weight was estimated by multiplying the total weight in the 300- μ sieve by the percentage of herbaceous fragments determined from microscopic examination. This method is believed to give a close approximation of the importance of woody plant material in the winter diet of arctic hares.

Results

General Morphology

Thirty-five arctic hares were collected at Mokka Fiord, Axel Heiberg Island in July and August 1973, and 16 from March to May 1975. The summer collection consisted of 10 adult males, 15 adult females, 6 juvenile males, and 4 juvenile females. The winter collection was composed of eight males and eight females. I did not distinguish between adults and young-of-the-year in the winter collection.

Summer and winter weights and measurements of adult hares are shown in Table 1. In the summer collection adult females were significantly heavier ($P < 0.01$) and of greater girth than adult males. Females collected in the winter

TABLE 1—The mean weights and measurements, with 95% confidence limits, of adult arctic hares (*Lepus arcticus*) collected at Mokka Fiord, Axel Heiberg Island during the periods 3 to 29 July 1973, and 23 March to 6 May 1975

Sex	Sample size	Weight (kg)	Length (mm)	Girth (mm)	Hindfoot (mm)	Shoulder height (mm)	Ear (mm)
1973							
Female	15	4.55 \pm 0.7	675.6 \pm 40.4	345.6 \pm 38.4	156.3 \pm 11.2	366.0 \pm 42.2	83.6 \pm 5.4
Male	10	4.13 \pm 0.5	669.0 \pm 28.8	338.0 \pm 29.8	154.6 \pm 8.4	355.5 \pm 28.4	82.6 \pm 5.2
1975							
Female	8	3.99 \pm 0.4	691.2 \pm 50.1	372.5 \pm 52.9	153.6 \pm 6.2	388.7 \pm 52.2	81.9 \pm 2.4
Male	8	4.08 \pm 0.2	690.6 \pm 38.8	361.9 \pm 44.1	150.2 \pm 9.4	386.4 \pm 35.2	83.0 \pm 5.7

weighed less than adult females from the summer collection ($P < 0.05$).

Weights for immature hares collected in July and August 1973 and a projected growth curve for the first six weeks of life are shown in Figure 2. Although adult females were generally heavier than adult males, the juvenile weights suggest that males put on weight more rapidly than females during the first six to eight weeks of life.

Cranial and mandibular measurements were taken whenever the condition of specimen material permitted. There was no trend evident in seasonal differences in those measurements.

Seasonal weights of selected internal organs of males and females are shown in Table 2. There were significant decreases in mean weights of the heart between summer and winter samples of both adult males ($P < 0.05$) and adult females ($P < 0.05$). Both sexes also showed significant decreases in kidney weight from summer to

winter (males, $P < 0.05$; females, $P < 0.001$). The liver also showed a seasonal loss of weight although the loss was significant ($P < 0.01$) only for females. Mean stomach weights of males were significantly ($P < 0.001$) heavier in the winter than in the summer. In females the mean stomach weight in winter was greater than that of summer but not significantly so. Winter increases could be attributable to a greater intake of woody material. The mean weights of lungs of both sexes were heavier in summer than in winter, although those differences were not significant ($P > 0.05$).

Reproduction

The ovaries of 15 adult female arctic hares collected in summer 1973 were sectioned and examined for corpora lutea of pregnancy. All females had ovulated and bred the previous breeding season. The mean number of corpora lutea for the sample was 6.5 (SD = 1.7). The mean

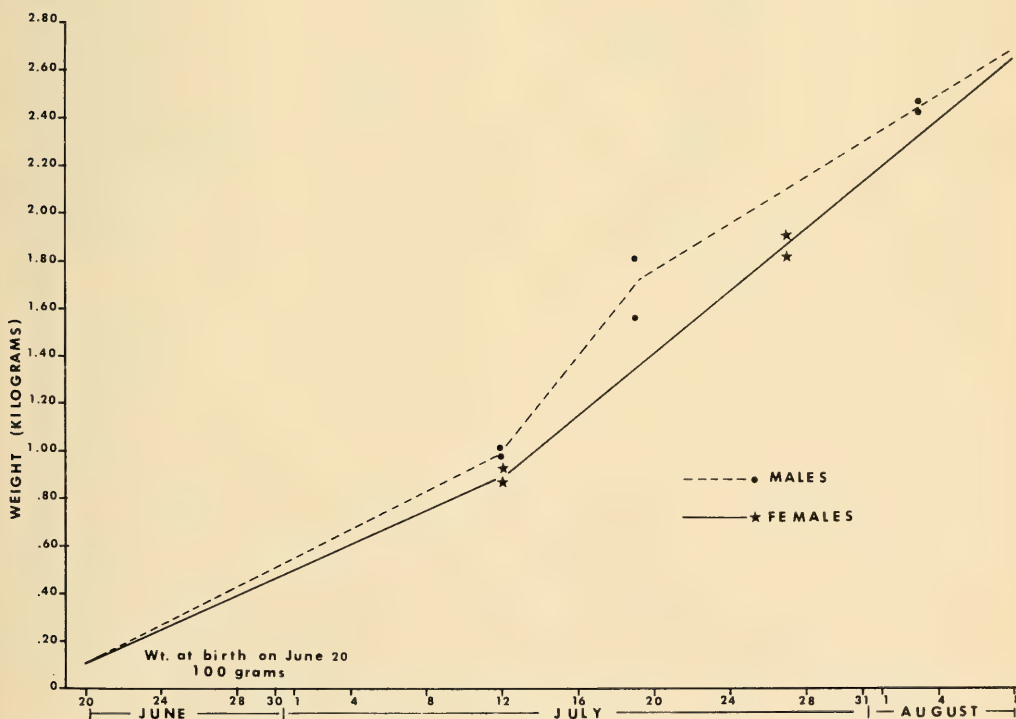


FIGURE 2. Weights of juvenile arctic hares collected at Mokka Fiord in summer 1973, and a projected growth curve from 20 June to 8 August 1973.

TABLE 2—Mean weights, in grams, of organs from arctic hares (*Lepus arcticus*) collected on Axel Heiberg Island, Northwest Territories in summer 1973 and winter 1975 (standard deviation in parentheses)

Collection period	Sex and age	Number of specimens* (n)	Heart	Lungs	Liver	Kidneys**		Stomach (full)
						Right	Left	
Summer 1973	Adult males	10	50.5 (6.0)	60.6 (20.7)	93.7 (14.0)	13.9 (1.1)	13.5 (1.0)	156.6 (19.2)
	Adult females	15	50.0 (5.3)	62.4 (12.5)	118.6 (23.8)	16.7 (2.0)	16.5 (2.2)	188.1 (67.4)
Winter 1975	Adult males	7	44.8 (4.4)	67.2 (10.7)	86.3 (33.6)	12.3 (1.6)	12.0 (1.3)	215.2 (29.8)
	Adult females	5	41.7 (8.3)	67.5 (24.2)	77.0 (28.8)	11.2 (1.8)	11.1 (1.8)	200.5 (25.6)

*Value of n may vary among organs owing to damage during collection.

**Weight of kidney minus fat.

number of corpora lutea for left ovaries was 3.3 (SD = 1.5) and for right ovaries 3.2 (SD = 0.4). The difference was not significant. The minimum and maximum number of corpora lutea for both ovaries was 5 and 11 respectively. A corpus luteum of pregnancy from a lactating female collected on 19 July is shown in Figure 3.

The ovaries of seven females collected from 23 March to 4 May 1975 were examined for developing Graafian follicles and corpora lutea. The ovaries of one of four specimens collected on 23 March contained numerous developing follicles although the ovaries from the other three contained but few. Developing and mature Graafian follicles and corpora lutea atretica were numerous in the ovaries of two specimens collected on 4 April (Figure 4). The right ovary of a female collected 4 May contained five recently formed corpora lutea (Figure 5), the left ovary two, suggesting that ovulation had occurred about 1 May.

The ovaries from the one female collected 4 May 1975 were much larger than ovaries of all other specimens. Corpora lutea in ovaries from the 1973 collection measured approximately $2.5 \times 1.5 \times 3.0$ mm; those from the one specimen at ovulation in 1975 approximately $2.5 \times 3.0 \times 5.0$ mm. Although corpora lutea were easily identified in the ovaries of females collected in the summer of 1973, the structures had disappeared from ovaries collected in March to May 1975.

The first young hare was seen on our arrival at Mokka Fiord on 22 June 1973. The brownish-gray coloration of young hares and their habit of remaining motionless behind stones made their detection difficult.

Food Habits

Thirty-five species or genera of vascular plants were identified in 23 stomach samples of adult arctic hares collected at Mokka Fiord during summer 1973 (Table 3). Of the 35 species or genera of plants recorded, 16 were grasses, 13 were dicots, and 6 were sedges. The mean percentages of epidermal fragments of those classes in the stomach samples were as follows: dicots 53, grasses 41, and sedges 6. Arctic willow was the most common plant species in summer stomach samples, followed by *Dryas integrifolia* and the grasses *Puccinellia Andersonii*, *Agropyron violaceum*, and *Arctagrostis latifolia*. Those five species accounted for 68.5% of the total plant fragments recorded. Only 11.6% of the recorded fragments could not be identified to genera or species, but all fragments could be classified as being grasses, sedges, or dicots.

Twenty-two species or genera of vascular plants were identified in 16 stomach samples of adult arctic hares collected at Mokka Fiord during late winter 1975 (Table 4). Non-woody material made up only 9.2% (SD = 2.9%) by weight of the winter stomach samples. The remaining 90.8% consisted of woody material

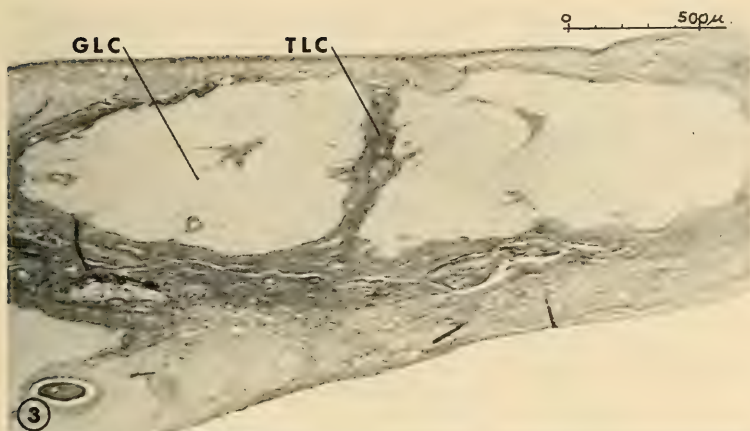


FIGURE 3. A corpus luteum of pregnancy from a lactating arctic hare collected at Mokka Fiord, Axel Heiberg Island, 19 July 1973. GLC = granulosa lutein cells; TLC = thecal lutein cells.



FIGURE 4. Developing Graafian follicles in the ovary of an arctic hare collected at Mokka Fiord on 4 April 1975. AF = atretic follicle; GF = growing follicle.

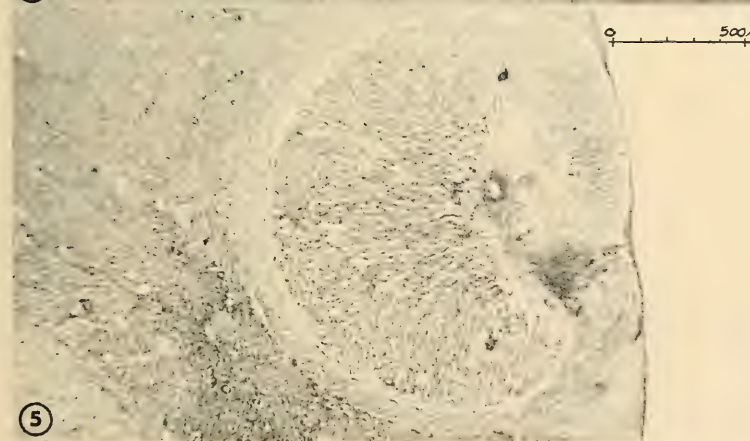


FIGURE 5. A recently formed corpus luteum of pregnancy of an arctic hare collected at Mokka Fiord on 4 May 1975.

TABLE 3—Plant species composition of stomach contents of 23 arctic hares (*Lepus arcticus*) shot in the summer at Mokka Fiord, Axel Heiberg Island, Northwest Territories. Determinations from microscopic identification of epidermal fragments

Plant species	Frequency	Mean relative density \pm SE*
<i>Dryas integrifolia</i>	100	16.6 \pm 2.44
<i>Salix arctica</i>	96	20.5 \pm 2.57
<i>Puccinellia Andersonii</i>	96	16.0 \pm 2.36
<i>Agropyron violaceum</i>	91	10.9 \pm 2.55
<i>Arctagrostis latifolia</i>	61	4.5 \pm 2.09
<i>Colpodium Vahlmanum</i>	61	1.1 \pm 0.33
<i>Alopecurus alpinus</i>	61	1.9 \pm 0.58
<i>Oxyria digyna</i>	57	2.9 \pm 1.34
<i>Draba</i> spp.	57	1.1 \pm 0.29
<i>Taraxacum</i> spp.	57	1.3 \pm 0.38
<i>Carex stans</i>	48	2.0 \pm 0.56
<i>Eriophorum</i> spp.	39	1.0 \pm 0.48
<i>Puccinellia angustata</i>	35	2.1 \pm 0.77
<i>Carex</i> spp.	26	2.3 \pm 1.44
<i>Saxifraga oppositifolia</i>	22	1.0 \pm 0.50
<i>Pedicularis</i> spp.	22	0.6 \pm 0.31
<i>Ranunculus pedatifidus</i>	17	0.3 \pm 0.19
<i>Poa</i> spp.	17	0.1 \pm < 0.10
<i>Saxifraga tricuspidata</i>	13	0.1 \pm < 0.10
<i>Polygonum viviparum</i>	13	0.1 \pm < 0.10
<i>Papaver radiculatum</i>	9	0.1 \pm < 0.10
<i>Ranunculus</i> spp.	9	< 0.1 \pm 0.21
<i>Puccinellia vaginata</i>	9	0.2 \pm 0.21
<i>Deschampsia brevifolia</i>	9	< 0.1 \pm < 0.10
<i>Luzula nivalis</i>	9	0.1 \pm 0.13
<i>Festuca baffinensis</i>	9	0.1 \pm < 0.10
<i>Poa arctica</i>	9	< 0.1 \pm < 0.10
<i>Epilobium latifolium</i>	9	0.5 \pm 0.40
<i>Hierochloa alpina</i>	4	< 0.1 \pm < 0.10
<i>Poa glauca</i>	4	< 0.1 \pm < 0.10
<i>Pleuropogon Sabinei</i>	4	< 0.1 \pm < 0.10
<i>Luzula arctica</i>	4	< 0.1 \pm < 0.10
<i>Carex nardina</i>	4	0.1 \pm 0.13
<i>Puccinellia poacea</i>	4	< 0.1 \pm < 0.10
<i>Festuca brachyphylla</i>	4	< 0.1 \pm < 0.10
Unidentified dicots	96	7.2 \pm 1.38
Unidentified grasses	96	3.5 \pm 0.44
Unidentified sedges	52	0.9 \pm 0.23

*Relative density = number of recognized fragments of a species expressed as a percentage of the total number of fragments of all species.

believed to be almost totally arctic willow. Willow also comprised 15.1% of the non-woody material in the winter stomach contents. *Dryas integrifolia*, *Salix arctica*, *Puccinellia* spp., *Agropyron violaceum*, and *Colpodium Vahlmanum* together made up 62.6% of the fragments in the non-woody portion of the winter stomach

contents. The approximate mean percentages of dicots, grasses, and sedges among the non-woody fragments were 70, 21, and 8 respectively.

Parasites

Cursory examination of the carcasses showed no evidence of internal parasites or pathology. Two adult hares collected in the late winter of 1975 were infested with the flea *Hoplopsyllus glacialis glacialis*, which has been reported from arctic hares in other regions of northern Canada, but these were the first records for Axel Heiberg Island (G.P. Holland, personal communication 1975). Seventeen specimens of the parasite were found on an adult female hare and two on an adult male. The female had scratched off patches of fur and cut the exposed skin with her claws.

TABLE 4—Plant species composition of non-woody stomach contents of 16 arctic hares shot in the winter at Mokka Fiord, Axel Heiberg Island, Northwest Territories. Determinations from microscopic identification of epidermal fragments

Plant species	Frequency	Mean relative density \pm SE*
<i>Dryas integrifolia</i>	100	37.3 \pm 3.23
<i>Salix arctica</i>	94	15.1 \pm 2.10
<i>Puccinellia</i> spp.	81	6.3 \pm 1.58
<i>Agropyron violaceum</i>	81	2.2 \pm 0.68
<i>Colpodium Vahlmanum</i>	75	1.7 \pm 0.35
<i>Draba</i> spp.	63	3.1 \pm 0.98
<i>Oxyria digyna</i>	63	2.3 \pm 0.63
<i>Eriophorum</i> spp.	56	1.1 \pm 0.38
<i>Carex</i> spp.	50	1.2 \pm 0.53
<i>Arctagrostis latifolia</i>	44	1.3 \pm 0.58
<i>Alopecurus alpinus</i>	44	0.6 \pm 0.20
<i>Pedicularis</i> spp.	38	0.4 \pm 0.15
<i>Taraxacum</i> spp.	38	0.7 \pm 0.43
<i>Festuca baffinensis</i>	31	0.6 \pm 0.28
<i>Carex stans</i>	25	0.6 \pm 0.33
<i>Polygonum viviparum</i>	19	0.5 \pm 0.38
<i>Hierochloa alpina</i>	13	0.1 \pm 0.08
<i>Poa</i> spp.	13	0.2 \pm 0.15
<i>Ranunculus</i> spp.	6	< 0.1 \pm 0.05
<i>Festuca brachyphylla</i>	6	< 0.1 \pm 0.05
<i>Saxifraga tricuspidata</i>	6	< 0.1 \pm 0.05
<i>Pleuropogon Sabinei</i>	6	< 0.1 \pm 0.05
Unidentified dicots	100	10.1 \pm 0.98
Unidentified grasses	100	8.0 \pm 0.98
Unidentified sedges	81	4.5 \pm 0.80
Unidentified monocots	19	0.8 \pm 0.43

*Relative density = number of recognized fragments of a species expressed as a percentage of the total number of fragments of all species.

Behavior

Adult hares had constructed numerous "scoops" or shallow dish-like depressions in the gravel ridges and slopes, usually facing south or southwest and behind, or sheltered by, a large rock. Hares often used those protected scoops during periods of unfavorable weather. Whether young were born in those scoops is not known but that seems likely. The young rapidly disperse, however, to spend the first two weeks of life hiding behind rocks, showing themselves only to nibble on vegetation, or to nurse. Lactating females were scattered throughout the lowlands, the young normally restricting their distribution to the gravel ridges and slopes.

By the third week of life, young hares had assumed their gray summer pelage and were forming nursery bands numbering up to 20 animals. Although adult females were still in the area, and occasionally within a herd of young, nursing was not observed. Young hares collected on 12 July were feeding mainly on vegetation although hardened chunks of milk remained in the stomach. The herds of young hares continued to grow in size throughout July. By early August most hares at Mokka Fiord had formed into several large herds, containing both young and adults, and were moving erratically throughout the valley.

The behavior of hares to human approach varied. Sudden approach, however, usually brought the hare to its hind legs, standing erect on its toes. That position affords the hare a better view and is probably the reason for its use. If the hare is unable to distinguish the object of disturbance and a rapid approach is continued, it usually flees in "kangaroo fashion." If pursued, the hare quickly drops to a quadrupedal position and moves up slope to cover, often assuming an upright stance once high ground is reached, to look back at the object of danger.

Solitary lactating females showed little fear of humans, often allowing an approach of several metres or less before slowly hopping away. Herds of young hares in late July and August exhibited a more nervous behavior, often fleeing for a kilometre or more on first sight of a human. I believe heavy predation on young hares by wolves (*Canis lupus*) and arctic fox (*Alopex lagopus*) caused that extreme flight behavior. Once the hares identified their pursuer as being

neither wolf nor fox, however, one was able to walk amidst them and be completely ignored. The behavior of the herd in winter was similar to that of late summer. Solitary hares in winter generally displayed more fear than in summer, but again individual behavior varied.

The two major predators of the hare at Mokka Fiord were the wolf and arctic fox. Killing was not observed, but both predators are believed to have relied heavily on young hares in the summer of 1973. Arctic fox were often seen carrying young hares to a nearby den. When young hares approached 2 kg in August, and became difficult for a fox to carry intact, the latter often transported the hare carcass in halves.

The remains of a young hare, approximately 10 days of age, was found at the nest of a Snowy Owl (*Nyctea scandiaca*) in 1973. The scarcity of owls in the study area, however, diminishes it as an important predator of the arctic hare.

Discussion

Arctic hares at Mokka Fiord, Axel Heiberg Island, are heavier than most southern races of the species but comparable in weight to specimens from other high arctic locations (Howell 1936) and Newfoundland (3.4 to 4.9 kg) (Northcott 1974). Waterston and Waterston (Waterston, G. and I. Waterston. 1972. Report on wildlife, vegetation and environmental values on the Queen Elizabeth Islands (Ellesmere and part of Axel Heiberg) June 28–August 15. Type-written report for Canadian Wildlife Service, Ottawa) recorded the weight of an adult lactating female on 15 July 1972 at Fosheim Peninsula, Ellesmere Island as 9 lb (4.1 kg). The mountain hare of Scotland (Flux 1970) and Norway (Walhovd 1965), however, weighs less than *Lepus arcticus monstabilis*.

The tendency for females to be generally larger in body size and weight than males is also in agreement with studies on hares in Scotland (Flux 1970) and Norway (Walhovd 1965). The decrease in weight by both sexes between summer and winter samples reflects a general summer-to-winter weight loss apparently typical of all species of hares (Hewson 1968). The weight loss is believed to result from a decrease in the quality of diet and approach of the breeding season, although the influence of juveniles in the

winter sample cannot be ignored.

The rate of growth of young arctic hares is much greater than for young mountain hares. Both Hewson (1968) and Flux (1970) report a weight gain of 14 g/day for mountain hares under 2 kg. Arctic hares during their first month of life exhibited an average daily weight gain of 45 to 50 g/day.

Flux (1971) refers to a 10% seasonal loss in kidney weight of European brown hares (*Lepus europaeus*) in New Zealand. I found kidney weights of arctic hares in winter to be 11–12% lower for males and 33% lower for females than summer weights. Dauphiné (1975) noted a greater loss in the weight of kidneys from female than from male barren-ground caribou (*Rangifer tarandus groenlandicus*) in northern Canada, although the difference was not as great as that reported here for the arctic hare. The loss of kidney weight during the winter period, as well as from the other major organs of arctic hares, is probably, as suggested for red deer (*Cervus elaphus*) by Batcheler and Clarke (1970), a physiological response to a decrease in forage quality and quantity and a reduction in the basal metabolism.

Arctic hares on Axel Heiberg Island have one litter per year, as do all populations of hares north of the treeline. In Norway the mountain hare may have up to three litters per year, averaging two to four young each litter (Walhovd 1965), as does the mountain hare of Scotland (Flux 1970). In Newfoundland the arctic hare may produce two to three litters per year (Northcott 1974). The Alaskan hare is similar to the arctic hare in having only one litter per year (Walkinshaw 1947). A decrease in the number of litters per year appears to be offset by an increase in the number of young per litter.

A corpora lutea count of 6.5 suggests the average litter size for hares on Axel Heiberg Island is approximately 5 (R. D. Baker, personal communication), slightly less than earlier records of 6 to 7 for hares from Greenland (Pedersen 1926; Manniche 1910, cited by Howell 1936), and 7 to 8 reported for northern Ellesmere Island (Feilden 1877, cited by Howell 1936). On Brunette Island, Newfoundland, J. Inder (personal communication 1976) reported a mean litter size for nine arctic hares of 3.8, the range being from 3 to 5.

I first saw young arctic hares at Mokka Fiord on 22 June 1973. Waterston and Waterston (*ibid.*) reported that female hares on the Fosheim Peninsula, Ellesmere Island gave birth to young between 29 June and 1 July 1972. On Greenland, young hares were first reported on 10 June (Walkinshaw 1947). In the Canadian High Arctic it appears that most births of arctic hares occur in the last 10 days of June.

Examination of ovaries from the 1975 collection suggests ovulation occurred approximately 1 May, giving a gestation period of 53 days. If we assume the birth of hares probably occurred several days prior to our arrival, the gestation period would be approximately 50 days, similar to the period of gestation of 50.3 ± 1.3 days for mountain hares in northern Scotland (Flux 1970).

Ovarian sections from females collected in the late winter and spring of 1975 suggest that an increase in follicular development begins near 1 April and continues throughout the month. Copulation induces ovulation in hares and the recently formed corpora lutea in the ovaries of a hare collected on 4 May suggests breeding took place near 1 May. Although structures resembling old corpora lutea of pregnancy were present in the ovaries of several females collected in late winter 1975, determining breeding success of the previous year by a count of such structures was not attempted and is not recommended.

Arctic hares showed a wide selection in their summer feeding habits, although willow, *Dryas integrifolia*, and several species of grasses made up the bulk of their diet. Whereas the new green growth of grasses and forbs composed the bulk of their summer diet, woody material accounted for over 90% of the winter diet, most of which is believed to be arctic willow. Approximately 15% of the herbaceous component of the winter diet was also willow, suggesting the total proportion of willow in the winter diet may approach 95%.

Sedges were not important in the diet of hares at Mokka Fiord. Sedges are largely confined to the low-lying meadows, areas where hares were seldom seen in summer or winter. The elevated and dry gravel slopes, where hares were most often found at all seasons, supported a sparse but rather diverse flora. Willow, *Dryas integrifolia*, and a variety of grasses and forbs were the dominant vegetation, suggesting that availa-

bility rather than selectivity probably dictates the diet of the arctic hare. I believe hares utilized the slopes more for escape and food availability because of a light snow cover, rather than food selectivity.

Information on the feeding habits of arctic hares in northern Canada is all but absent in the literature. Studies of the mountain hare in Sweden (Lindlof et al. 1974), northeast Lapland (Pullianinen 1972), and Finland (Nyholm 1968) stress the importance of willow in the winter diet. Winter habitat of hare in Scandinavia, however, often includes regions which support shrubs and trees. Bonnyman (1975), after observing feeding hares in late May, mentions the importance of willow in the winter diet of hares on Fosheim Peninsula, Ellesmere Island.

Arctic willow is the dominant plant species over much of the Fosheim Peninsula and on eastern Axel Heiberg Island (Inglis, J. T. and C. J. Jonkel. 1972. Ellesmere Island range studies. Canadian Wildlife Service, Ottawa, MS report. 24 pp.). The abundance of that food source, a light covering of winter snow assuring continuous availability, and broken terrain providing escape cover, may explain the abundance of hares in those areas in contrast to their relative scarcity over most of the Canadian Arctic.

My observations suggest that the arctic hare may be an important competitor with muskoxen and caribou during the winter period when all three species feed upon willow. Whether such competition reaches a level where one or more of the mammal species is adversely affected has not been demonstrated. Such competition would occur only where arctic hares reach extremely high densities such as on Axel Heiberg and Ellesmere Islands. My observations indicate that caribou and muskoxen are not as species-restricted in their winter diet as the hares. Caribou feed extensively on upland grasses and sedges while the winter diet of muskoxen may contain a high proportion of lowland sedges.

At Mokka Fiord, one herd of 250–300 hares spent the winter of 1974–75 within an area of approximately 35 km². Their winter movements could be traced in March by distribution of pellets, remains of broken and uprooted willow, and trampled snow. An area used by hares in early winter becomes virtually unavailable for

further use by hares, muskoxen, or caribou. The loose snow cover is quickly compacted by the hares, and the extreme temperature and wind abrasion create a firm layer which adheres to the ground. Although perhaps only a few centimetres thick, it becomes extremely hard. In contrast, adjacent areas not trampled by hares build up a deeper covering of snow; a typical late winter profile would show a thick upper crust over a layer of loose ice granules and air pockets. Where the snow has not been disturbed, a muskox can expose an area of vegetation with several blows of its front feet, tossing the broken crust aside and removing the loose ice granules with its hoof or muzzle. Although a potential for interspecific competition for food appears to exist, muskoxen at Mokka Fiord displayed such a broad selectivity of habitat for feeding that adverse effects of competition were negligible or absent.

A high density of hares must certainly play an important role in the energy-flow cycle in a relatively closed high-arctic ecosystem such as the Mokka Fiord valley. The importance of muskoxen, caribou, and hares in such a system is poorly understood. A systems approach for further research is highly recommended for such unique areas as the Mokka Fiord valley and Fosheim Peninsula on Ellesmere Island.

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Life History Observations of Three Species of Snakes in Manitoba

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Abstract. Since little is known about the natural history of plains garter snakes, red-bellied snakes, and green snakes, especially in the northern parts of their ranges, various data on these three species were collected over a 3½-year period in the Interlake region of Manitoba. As the ecology of the red-sided garter snake in this area is considerably different from elsewhere in its range, similar geographic variation might be expected for the three species studied here. Few differences are in fact obvious; diets, activity cycles, growth, and reproductive features are all basically similar to those in other parts of the species' ranges. A comparison of the two garter snake species would be of interest for future study because in Manitoba these species apparently exhibit similar growth and reproductive potential, as they do in other parts of their joint range, but have rather different annual cycles of activity.

Considerable information has been published recently concerning the natural history of the red-sided garter snake (*Thamnophis sirtalis parietalis*) in Manitoba. These publications have covered activity both at overwintering sites (Aleksiuk and Gregory 1974; Gregory 1974) and in summer habitat (Gregory 1975; Gregory and Stewart 1975) and have concentrated on the Interlake region of the province, between Lake Manitoba and Lake Winnipeg. To date, however, little work has been done on the other four species of snakes which occur in Manitoba: the western plains garter snake (*Thamnophis radix haydeni*), the northern red-bellied snake (*Storeria occipitomaculata occipitomaculata*), the smooth green snake (*Opheodrys vernalis*), and the plains hognose snake (*Heterodon nasicus nasicus*). The subspecific status of *Opheodrys vernalis* in Manitoba is unclear; Grobman (1941) considers them to be *vernalis* × *blanchardi*.

Thamnophis radix, *Storeria*, and *Opheodrys* all occur in the southern part of the Interlake region, but none is apparently as abundant as *T. sirtalis* in this area. In all three cases, the southern Interlake is the northern limit of distribution for the species at that longitude (Logier and Toner 1961; Conant 1975). *Thamnophis radix*, however, does range somewhat further north to the west of the Interlake region, closely following the limit of prairie grassland. Jordan (1967) indicated that this species is

largely restricted to this habitat. *Heterodon* is confined to the southwestern portion of the province (Scott 1970).

While conducting field studies of *T. sirtalis* from fall 1969 to spring 1973, I occasionally encountered individuals of *T. radix*, *Storeria*, and *Opheodrys*. Since little is known about the ecology of these species, especially near the northern limits of their ranges where interesting life history strategies might be expected, I decided that it would be worthwhile to collect information on various aspects of their natural histories. Data on seasonal activity, diets, body size and age classes, and various aspects of reproduction were of particular interest as they could be readily obtained from living animals. A few attempts were made to obtain information on hognose snakes, but only one road-killed specimen was found. Specimens of *Heterodon* were occasionally brought in to the Department of Zoology, University of Manitoba, the most notable being a juvenile found as late as 1 October in 1972, but no data were obtained from any of these.

Study Area and Methods

Most of the data presented in this paper were collected from snakes found in the southern Interlake region of Manitoba. This area, described in an earlier paper (Gregory and Stewart 1975), consists of a series of ridges covered with

aspen forest and cleared farmland with marshes in the depressions between the ridges. Snakes were occasionally found in other parts of Manitoba such as around the southern part of Lake Manitoba or in the southwestern portion of the province. Both of these areas are generally more open, with considerably more grassland, than the Interlake.

No particular sampling plan was followed with respect to the collection of data as the snakes were generally found while I was searching for *T. sirtalis*. Also, because I did not decide to collect data on the three species in an organized way until I was about half-way through my studies, the data are rather incomplete, varying from simple reported sightings to full information on particular specimens. Sampling effort was fairly evenly spread over the whole study period. In April, May, September, and October my efforts were concentrated at hibernacula of *T. sirtalis*; in June, July, and August I generally searched for snakes away from known denning areas.

The time period covered by this paper is from the autumn of 1969 to the autumn of 1972. In general, captured snakes were sexed, measured (snout-vent length, SVL) to the nearest 5 mm, palpated to force regurgitation of stomach contents, and individually marked for future identification by the removal of subcaudal scutes in unique combinations. The reproductive condition of females was noted and some gravid females were taken back to the laboratory where further reproductive information (dates of birth, brood sizes, etc.) was collected.

Results

Thamnophis radix, Plains Garter Snake

During the course of this study, 56+ specimens of *T. radix* were collected in spring and fall at communal hibernacula largely occupied by *T. sirtalis*; more than 51 specimens were observed and/or collected at locations other than dens. Earliest and latest dates of observation were 26 April (1971) and 16 October (1970) respectively, both at den-sites. Earliest and latest observations away from dens were made on 2 May (1972) and 4 October (1970).

Thirty-three of the snakes found at dens were females and 12 were males; the sexes of the

remaining snakes were not noted. All but seven of the specimens from dens were caught in the fall; three of the seven found in spring were crow-kills. Only three of the snakes marked at dens were recaptured and in each case the recapture was made in the same fall season as that in which the snake was first seen; the longest interval between first and second captures was 11 days. Only one attempt was made to palpate food from a snake's stomach at a den-site and no food was obtained.

Thamnophis radix was occasionally found at all dens numbered in Figure 2 of Gregory and Stewart (1975) and at a few others not indicated in that figure. By far the largest number (22) was observed at Den 1. In addition, more specimens (22+) of *T. radix* were observed at dens in the fall of 1970 than at any other time. Two instances of suspect interspecific mating activity were observed at dens in 1972 (8 and 10 May); in both cases, a female *T. radix* was being chased or mobbed by a few male *T. sirtalis* in the manner characteristic of mating *T. sirtalis* (Aleksiuk and Gregory 1974). The outcome of this activity was not observed either time as the groups rapidly dispersed upon my arrival.

Most snakes encountered away from dens in summer were found in or near marshes or in meadows adjacent to marshes; snakes were occasionally found in areas of aspen forest. Road-kills formed the majority of the more than 20 dead specimens found, while more than 31 snakes were caught or observed live. Thirty-five of the snakes sexed were females, and 13 of these were gravid. Seven of the sexed snakes were males. None of the summer-marked snakes was ever recaptured. Of 21 specimens palpated, 14 produced no stomach contents. Three snakes each contained one wood frog (*Rana sylvatica*), one a chorus frog (*Pseudacris triseriata*), one seven unidentified tadpoles, one an unidentified leech, and the last contained unidentifiable remains.

Six of the gravid females found in summer yielded information concerning brood sizes, time of birth, and other reproductive features. These data are summarized in Table 1. The three gravid females kept in an outdoor compound at the University of Manitoba (see Table 1) also provided the only individual growth data I was

TABLE 1—Summary of information on brood sizes and birth dates for *Thamnophis radix*

Date found	S-V length, mm	Reproductive information
22 June (1972)	690	Kept in outdoor compound until 31 July. Gave birth to 35 live and 4 stillborn young on 3 August
22 June (1972)	710	Kept in outdoor compound until 25 July. Gave birth to 51 live and 3 stillborn young on 8 August
3 July (1972)	645	Kept in outdoor compound until 31 July. Gave birth to 11 live and 5 stillborn young on 24 or 25 August
3 July (1972)	580	Found as road-kill and dissected; contained 28 embryos and 41 ovulation scars (corpora lutea)
20 July (1972)	660	Found as road-kill and dissected; contained 14 embryos (similar to stage 37 of <i>T. sirtalis</i> (Zehr 1962)) and 33 ovulation scars
11 August (1971)	650 (10 Sept.)	Kept in laboratory. Gave birth to 25 live and 1 dead young between 3 and 6 September inclusive (average SVL of 22 young was 187.3 mm)

able to obtain; these data are presented in Table 2.

The SVLs of all measured snakes are shown in Figure 1; 41 of these were obtained at dens and 22 away from dens. These data are combined for all years, shown by calendar date, and divided

into males, obviously gravid females, other females, and unsexed. The lines enclosing various groups of points indicate what I feel may represent real age classes, based on apparent tendencies of increasing size throughout the summer and taking into account the size of newborn young (Table 1).

Storeria occipitomaculata, Red-Bellied Snake

No overwintering sites were known for this species in the Interlake. Most specimens were found in generally open areas such as marshes or meadows, although a few were found in areas of aspen forest. Both gray and brown color morphs were included in the sample, but the number of each was noted. Twenty-eight specimens were found, six of them dead. Eighteen were identified as females, of which eight were obviously gravid, and two were identified as males. None of those marked was ever recaptured. Earliest and latest calendar dates of observation were 31 May (1970, 1972) and 5 October (1971). Seven snakes were palpated without success for stomach contents.

No information on brood sizes was obtained, although one female produced at least two young in captivity between 28 July and 3 August in 1972. One road-killed specimen found on 6 August 1971 had six poorly developed embryos in the left oviduct. A second road-kill found on 22 August 1972 had a copulatory plug in the cloaca indicating recent mating.

Figure 2 shows the SVLs of the 12 *Storeria* which were measured in the same manner as in Figure 1 for *T. radix*.

Opheodrys vernalis, Smooth Green Snake

Forty-one green snakes were found during the study period, 11 of them dead. These snakes were found about equally in wooded areas and in

TABLE 2—Snout-vent lengths (mm) of three gravid female *Thamnophis radix* at various dates during period when held at University of Manitoba in 1972. Vertical lines indicate time interval when parturition occurred

Snake No.	22 June	3 July	25 July	9 August	29 August
1	690			705	
2	710		730	735	
3		645			660

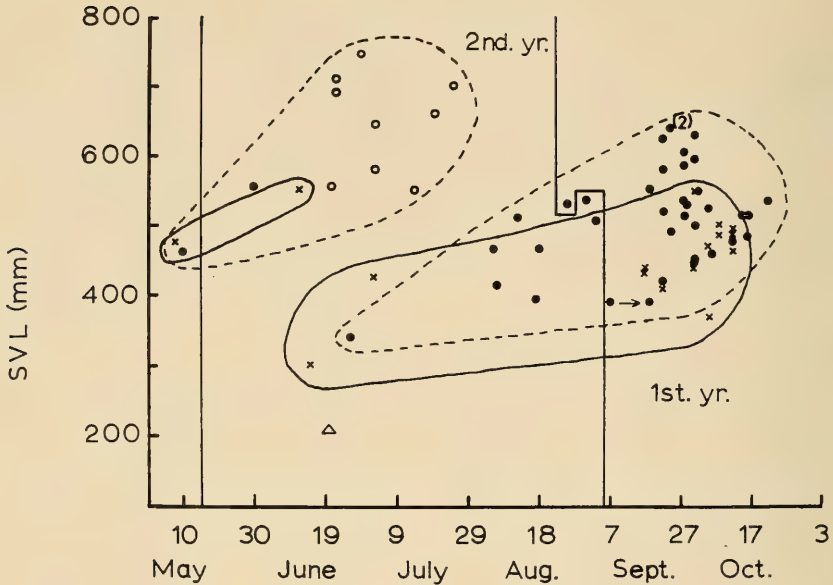


FIGURE 1. Distribution of sizes of *Thamnophis radix* over active season. o = gravid female, ● = non-gravid female, x = male, △ = unsexed. Points between vertical solid lines represent summer-caught snakes; other points represent den-caught specimens. Enclosed groups of points represent presumed year classes, dashed lines for females and solid lines for males. Arrow connects two points representing same individual. Parenthesized numbers indicate more than one snake of a given size at a particular date.

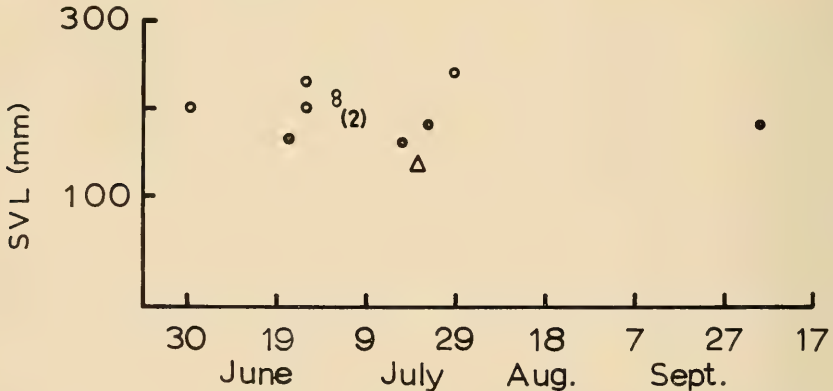


FIGURE 2. Distribution of sizes of *Storeria* over active season. Symbols as in Figure 1.

meadows adjacent to marshes. No denning sites were known for green snakes in the study area. Nineteen of the sexed individuals were females, of which eight were gravid, and 13 were males. No marked snakes were subsequently recaptured. The earliest date of observation was 28

April (1972) and the latest 23 August (1971).

Twenty-three stomach examinations were made. Seven of these produced food items. Three snakes each contained one grasshopper, two contained one caterpillar, one contained two caterpillars, and one contained arthropod

remains. Further taxonomic identification of these prey items was not attempted.

Clutch sizes were obtained for four gravid females. One female measuring 285 mm SVL was found on 26 June 1972 and palpated, revealing six ova. Three females found in a group on 26 June 1972 (referred to in Gregory 1975) contained five eggs each. The SVLs of these snakes were 280, 285, and 290 mm. One of the snakes died two days after capture and was found, upon dissection, to contain eggs with shells. A second laid three eggs on 29 June and then died; the remaining two eggs had shells. The third specimen laid her eggs between 14 and 17 July, inclusive. None of the 15 eggs survived to hatching, but the conditions provided them were not optimum. A female caught on 9 July 1972 (275 mm SVL) had very loose skin in the abdominal region, similar to that of females which have recently oviposited.

Figure 3 summarizes SVL data for the 24 specimens of *Opheodrys* which were measured.

Discussion

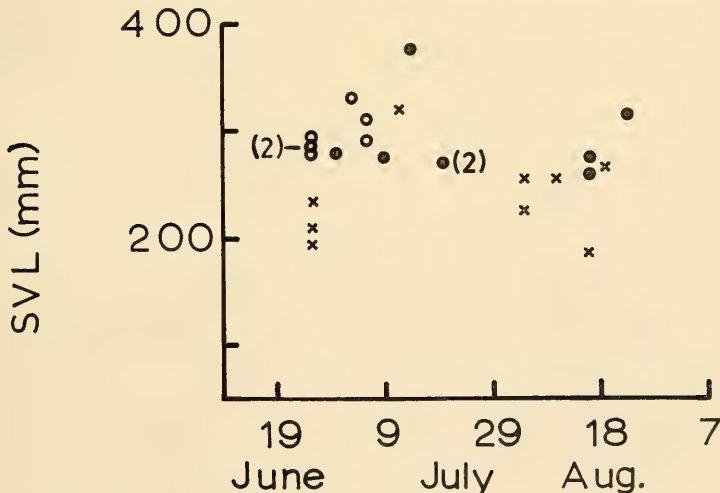
Habitats, Food, and Seasonal Activity

The habitats described for the three species in this paper are probably not representative since habitat type was not very often noted. In addition, most of my field time was spent in

marshes and adjacent meadows, the usual summer habitat of *T. sirtalis* (Gregory and Stewart 1975), thus biasing the capture locations of the other three species.

Stomach examinations made of all three species suggest a similar situation to that described for *T. sirtalis* (Gregory and Stewart 1975): snakes feed fairly infrequently. The stomach samples obtained from *T. radix*, although few in number, all represent prey items also eaten by *T. sirtalis*. D. Platt (personal communication) found that the two species had similar diets in Kansas. No samples were obtained from *Storeria*, but Stebbins (1966) and Conant (1975) indicate that this species eats slugs, earthworms, and soft-bodied insects. These food types are all available in the Interlake. *Opheodrys*, as indicated elsewhere (Blanchard 1932; Judd 1960; Stebbins 1966; Conant 1975), is largely insectivorous.

Thamnophis radix, *Storeria occipitomaculata*, and *Opheodrys vernalis* all appear to have a longer active season away from hibernacula each summer than do sympatric populations of *T. sirtalis*. I have occasionally found *T. sirtalis* active away from den sites at the times of earliest and latest captures recorded here (the earliest capture for *Storeria* and latest capture for *Opheodrys* are ignored here), but *T. sirtalis* is



generally congregated at denning sites at such times. It is unlikely that the early and late *T. radix*, *Storeria*, and *Ophedrys* specimens were simply exceptional individuals. The relatively small number of *T. radix* caught at dens in spring, as compared to fall, suggests that dispersal in this species must take place shortly after emergence. Also, those specimens found at dens in spring were generally found early in the season. Lang (1971) found that *Storeria* arrived later in fall and emerged earlier in spring at hibernacula in Minnesota than did either *Ophedrys* or *T. sirtalis* (mostly young). In all three species, dispersal took place very soon after spring emergence, although the overall period of emergence was fairly lengthy.

By contrast, adult male *T. sirtalis* in the Interlake may spend as much as a month at den-sites before dispersing in spring (Gregory 1974), this tenure being apparently related to the intense mating activity characterizing this stage of the annual cycle. Females disperse after mating. Individual snakes of both sexes spend considerable time at the den-sites prior to entering into hibernation in the fall. For some males, the time spent in the vicinity of hibernacula may represent half of the annual active season.

Storeria and *Ophedrys* in the Interlake presumably overwinter communally in abandoned ant mounds, as described by Lang (1969, 1971) in Minnesota and by Criddle (1937) near Treesbank, Manitoba. Being small species, they (as are young-of-year garter snakes) are probably capable of using a large variety of structures in which to hibernate and likely have little difficulty locating suitable hibernacula in their summer ranges. Lang also found young *T. sirtalis* in his hibernacula and Criddle found juvenile *T. radix*. Young garter snakes of either species are not known normally to overwinter with the adults in the Interlake and possibly also use ant-mound hibernacula. Ant mounds of the type described by the two authors above are abundant throughout my study area but attempts to find some containing snakes failed. Adult *T. radix* apparently do not usually hibernate in large groups as do adult *T. sirtalis* (Gregory 1973). D. Hart (personal communication), however, has observed one instance of

small-scale communal denning in *T. radix*. In general, adult garter snakes are probably more restricted in choice of hibernacula because of their relatively large size and either find sites capable of accommodating large numbers (*T. sirtalis*) or hibernate in smaller numbers (*T. radix*).

Sex Ratios, Growth, and Reproduction

The sex ratios presented in this study are biased in favor of females and cannot be considered representative for any of the three species. This is attributable in part to the non-rigorous manner in which data were collected and to the lack of complete information for many specimens. In addition, the relative proportions of females for the two live-bearing species (*T. radix* and *Storeria*) are further inflated since gravid females are more easily seen and caught. This is because gravid females tend to bask in exposed areas, presumably to promote development of their broods (Blanchard 1937; Gregory 1975). This does not explain, however, why more females than males of *T. radix* were caught at dens. Similar samples of *T. sirtalis* at the same dens generally yielded more males than females.

Thamnophis radix apparently grows at about the same rate as does *T. sirtalis*, females being larger than males of the same age. This is based mainly on the data presented in Figure 1 and in Gregory (1973). Similar growth rates are implied for *T. radix* in the Chicago region (Seibert and Hagen 1947) where the growing season is from the end of May to the first week in September. This is about the same as the growing season for *T. sirtalis* in Manitoba. Platt (personal communication) found growth rates of *T. sirtalis* and *T. radix* to be similar in Kansas, where both species apparently hibernate in their summer habitat. The relatively small amount of growth shown by the captive gravid females (Table 2) may be an artifact of captivity; on the other hand, gravid females of many species of snakes do not feed very often (Gregory and Stewart 1975) so that little growth might be expected even under natural conditions.

Communal mating such as described for *T. sirtalis* (Aleksiuk and Gregory 1974) is not known for any of the three species studied here.

There is in fact no evidence of mating activity of any kind at den sites in these three species. Possibly, however, dispersal in *T. radix*, *Storeria*, and *Opheodrys* does not involve such long movements as the 4.3 to 17.7 km in *T. sirtalis* (Gregory and Stewart 1975) and the probability of finding a mate in the summer habitat may be greater. Lang (1969, 1971) indicates that *Storeria* move less than 3000 ft (about 914.4 m) away from their denning sites in summer.

The possibility of interbreeding between the two garter snake species is suggested by the observations of male *T. sirtalis* chasing female *T. radix*, although I have never seen what I took to be a hybrid nor have I heard of one. Both these instances were observed near the beginning of the peak period of mating of *T. sirtalis*, when the activity is extremely frenzied at den sites. Perhaps male *T. sirtalis* are not very discriminatory at such times or the female *T. radix* had been in close contact with female *T. sirtalis* and retained some of their odor. Odor is very important in attracting male *T. sirtalis* to females (Fitch 1965; Aleksuik and Gregory 1974). It is unfortunate that the end result was not observed in either case, but the lack of known hybrids suggests that nothing viable would have resulted.

Both species of garter snake normally mature in their second year (Seibert and Hagen 1947; Fitch 1965; Gregory 1973; Platt, personal communication), although Platt found that individuals of either species could sometimes reproduce in their first year when food was abundant. In the Chicago area, *T. radix* mates in late April and early May (Cieslak 1945). Birth in *T. radix* in Manitoba (Figure 1, Table 1) takes place from early August on, at about the same time as in *T. sirtalis* (Gregory 1973). The one staged group of embryos (Table 1) is in line with development in *T. sirtalis* (Gregory 1973), assuming similar stages in both species. Cieslak (1945) found that parturition of *T. radix* occurred from 2–23 August, but was concentrated in the first week of August. In Kansas, *T. sirtalis* and *T. radix* both give birth from late July on (Platt, personal communication). The litter sizes reported for *T. radix* in Table 1 appear to be somewhat larger than for female *T. sirtalis*

of the same SVLs (Gregory 1973), but the sample is small. Platt indicates little difference in litter size between the two species, and Cieslak (1945) reports an average litter size in *T. radix* similar to that in *T. sirtalis* (Fitch 1965; Gregory 1973). The average SVL of the single litter of *T. radix* measured (Table 1) is towards the upper end of the range in newborn sympatric *T. sirtalis* (Gregory 1973).

Accurate estimates of brood size in *Storeria* were not obtained, but Blanchard (1937) indicates a range from 1 to 13. My data (Figure 2) suggest that young may be born any time from early July on, but so few gravid *Storeria* were found that this may be very misleading. Blanchard (1937) indicates that young are generally born from early August on, as in garter snakes. The sizes of gravid females reported here are at the low end of the range or slightly below the range reported by Blanchard, but all of my specimens were collected in early summer before much growth had taken place. Presumably, females are able to bear young by their second year (Blanchard 1937). The discovery of a copulatory plug in a female *Storeria* in late summer indicates that fall mating takes place, although it may simply be occasional as in *T. sirtalis* (Aleksuik and Gregory 1974). The work of Trapido (1940), however, suggests that fall mating is probably the rule and that the females retain the sperm *in utero* overwinter. The *Storeria* found in this study were comparable in size to those measured by Lang (1971).

Green snakes in Manitoba are also similar in size to those reported elsewhere (Seibert and Hagen 1947; Judd 1960; Lang 1971), females being larger than males (Seibert and Hagen 1947). They probably begin breeding in their second year (Seibert and Hagen 1947); reproductive females in Manitoba are about the same size as those recorded by Judd (1960). Being oviparous, this species oviposits somewhat earlier in the summer than the other three species bear their young. The evidence is fairly strong (Figure 2, plus other observations) that eggs are laid from late June to mid-July. This is similar to the egg deposition period reported for *Opheodrys* near Chicago (Stille 1954). Blanchard (1932), however, found that this species in northern Michigan laid its eggs much later than

this, usually in the first three weeks of August. Judd (1960) reported finding a female which had evidently oviposited very recently on 7 August in southern Ontario. This disparity is interesting because Neill (1964) indicates that *Opheodrys* has a tendency to retain its eggs longer towards the northern part of its range, approaching a state of ovoviviparity. Stille (1954) also notes this phenomenon and Blanchard (1932) alludes to it in citing an example of a clutch which hatched four days after being laid. On this basis, one would expect a later, rather than earlier, oviposition date for the species in Manitoba. Stille (1954), however, indicates that year-to-year variability in egg deposition dates is fairly great and that early oviposition is correlated with higher average temperatures in May, presumably because development is initiated earlier. Most of my reproductive data were collected in 1972 when May temperatures were much higher than normal (Annual Meteorological Summary, Environment Canada, Winnipeg 1972); this possibly explains the early dates observed, but more data over several years are obviously needed. Blanchard (1932) indicates that rough handling of the females may cause premature deposition of eggs. The three females from which clutches were obtained were also palpated for food and this may have constituted sufficiently rough handling that premature oviposition occurred. It is therefore possible that normal oviposition dates may be somewhat later.

According to Blanchard (1932), the number of eggs per clutch in smooth green snakes ranges from 3 to 11 with a mode of 7; Stille (1954) and Judd (1960) obtained similar figures. Those clutch sizes reported here are consistent with theirs. Blanchard (1932) also mentions that it is fairly common for female *Opheodrys* to lay their clutches in two or more batches, although this may often be associated with abnormal conditions. This may have been the case with the female that laid three eggs and died before laying the last two.

Conclusion

Evidently, on the basis of the limited data presented here, the ecology of *T. radix*, *Storeria*, and *Opheodrys* in the Interlake region of

Manitoba is not greatly different from elsewhere in their ranges. This is interesting since Interlake populations of *T. sirtalis* exhibit many life history features that are considerably different from those of populations in other parts of the range (Aleksiuk and Gregory 1974; Gregory 1973, 1974; Gregory and Stewart 1975). *Thamnophis sirtalis* is apparently much more abundant in my study area than the three species reported on here and perhaps these life history features represent major adaptations which at least partially explain its numerical superiority (Gregory 1973, 1974). The Interlake environment, however, is extremely rigorous for a reptile (Gregory 1973) and further study of the other three species may reveal interesting ecological and/or physiological adaptations. A comparison of the life histories of *T. radix* and *T. sirtalis* would be of particular interest since parameters such as annual growth and reproductive potential appear to be similar in the two species in Manitoba despite obvious differences in their annual activity cycles. In other areas where the two species occur, they are apparently similar in both respects.

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Status and Habits of the Cougar in Manitoba

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Abstract. A cougar (*Felis concolor missoulensis*), collected at Stead, Manitoba in 1973, and 281 well documented sightings establish the species as resident in the province for the first time. Though there are cougar sightings from 1879 to 1975, the majority are recent (40 in 1974). Prior to 1940, the cougar was restricted to the grassland and aspen-oak transition of extreme southwestern Manitoba—within the ranges of mule deer and American elk. After 1940, these two prey species became rare and localized, and white-tailed deer became the dominant big-game animal, spreading far north into the boreal forest. Recent cougar distribution is closely associated with that of the white-tailed deer, an apparent doubling of the cougar's range. A rough estimate of the cougar population in Manitoba is 50, and it seems likely that some individuals have been observed in adjacent Saskatchewan, North Dakota, Minnesota, and Ontario.

Until recently, it was generally assumed that the cougar had been exterminated east of the Rocky Mountains, except for a small Florida population of between 50 and 100 animals (Wright 1972). Occasional sightings continued, however, in every Canadian province (e.g., Saskatchewan, White 1967; New Brunswick, Wright 1959, 1972) except Prince Edward Island and Newfoundland, and in many central and eastern states (e.g., Pennsylvania, Douth 1969; Maine to Alabama, Wright 1972). Most reports (from non-biologists) were not taken seriously, and consequently, valuable information that should have been accumulating on this endangered species has been lost.

The objectives of this paper are to describe the history and present status of the cougar in Manitoba (and to a lesser extent in adjacent regions), relate its distribution in the province to prey and cover, and examine the animal's habits in this part of its range.

Early historical accounts offer little information on the presence of cougars in Manitoba. The fur trader, Alexander Henry, made no mention of this cat in his extensive travels throughout the southern part of the province and adjacent states during the years 1799 to 1808 (Coues 1897). A possible reference to cougars was the name, Tiger Hills, given by early settlers to a plateau situated south of the Assiniboine River between the Cypress River, Wawanese, and Ninette.

The first accounts of Manitoba mammals by Thompson [Seton] (1886) and Seton (1909) did not include the cougar, but in a subsequent work Seton (1925–1928) listed seven localities in southwestern Manitoba where the animal had been seen or shot. A few additional records found their way into the literature, but despite the availability of a specimen taken just over the border in Saskatchewan in 1948 (Beck 1958), the absence of any authenticated Manitoba specimen in a museum resulted in this province being omitted from northern distribution limits plotted for the species by Young and Goldman (1946) and by Hall and Kelson (1959).

In 1973 a cougar was shot in a farmyard at Stead, 56 km northeast of Winnipeg. The specimen, which is now in the Manitoba Museum of Man and Nature, gives substantial support to the mounting evidence that Manitoba and adjacent regions of midwestern Canada and the United States support a resident cougar population, almost 1000 km east of the recently accepted range for the species.

Methods

Most of the early records from Manitoba were published by Seton (1925). Thereafter, reports were investigated and recorded by two former directors of the Manitoba Museum, L. T. S. Norris-Elye (1951) and his successor, Richard W. Sutton (1960). W. Harvey Beck, an assistant curator at the Manitoba Museum of Man and

Nature, started a card file on cougar records in 1968 to which were added records gathered by Charles H. Buckner, Federal Forest Biology Laboratory in Winnipeg. In 1972 the senior author initiated a program to obtain and record additional past and new cougar observations in order to document further the status of this species in Manitoba. At that time the cougar was not identified as a game species or as a predator and, if anything, was regarded as a rare transient. Letters and a preliminary report were sent to field staff of the Department of Renewable Resources and Transportation Services, requesting their cooperation in the project, and a questionnaire was sent to Provincial Game and Fish associations. No attempt was made to advertise broadly our interest in receiving further reports from the general public. Many reports were investigated further by a letter, telephone call, or personal contact with the original observer, in the hope of obtaining date, location, time, lighting conditions, length of observation, distance to animal, color, description, behavior, reasons for suspecting cougar, and number of observers. Most observers indicated a reluctance to publicize their observation for fear of inviting ridicule, and it was learned that a number of sightings had been reported to local authorities at an earlier date, but went unrecorded before our survey owing to a general skepticism regarding the occurrence of the cougar in Manitoba.

Finally, cougar data were requested from wildlife agencies, museums, and universities in Saskatchewan, Ontario, North Dakota, and Minnesota to compare trends of sightings and the extent of adjacent cougar populations.

This study is based on observations by people with a wide range of occupations and backgrounds. How credible are these sightings? Obviously, there is no way to prove the reliability of a report short of obtaining a specimen or photograph. Most reports accepted by us as valid and used in this study consisted of a good description of the animal, including its behavior, and pertinent details regarding the circumstances of the sighting. Our judgment was also based on other factors; for example, when a number of people saw cougars in the same region, unknown to each other, the evidence became more convincing. Other kinds of evi-

dence such as tracks, calls, and the presence of partly eaten wild or domestic prey, provided support for some records, but otherwise were not used to establish the occurrence of the species. Knowing that certain other species may be confused with the cougar, namely, deer, wolf, coyote, dog, and lynx, particularly if the observation is made at a great distance or under poor conditions, we made a special effort personally to check reports. Many sightings were rejected on the basis of insufficient evidence.

Results

Cougar Sightings

There are now records of 281 sightings of cougars in Manitoba for the period from 1879 to 1975, four prior to 1900, and including three in which the animal was allegedly killed (Table 1). From 1900 to 1950 there are one to seven reports per decade; however, 10 cougars were supposedly killed during those 50 years (Figure 1). Unfortunately none of these specimens was saved (several were exhibited for a time in local store windows), partly because the provincial museum was not established until 1932. Since 1950 there has been a great increase in the number of reports received, with 159 during the 1970s and 40 for 1974 alone. Numerous sightings have

TABLE 1—Number of cougars seen and reported killed in Manitoba from 1879 to 1975

Year	Number of sightings	Number of kills
1870-1879	1	1
1880-1889	1	1
1890-1899	2	1
1900-1909	7	4
1910-1919	1	1
1920-1929	5	3
1930-1939	6	2
1940-1949	4	0
1950-1959	27	0
1960-1969	68	1
1970	8	0
1971	14	0
1972	37	0
1973	35	1
1974	40	0
1975	25	0
Totals	281	15

undoubtedly gone unreported from earlier years.

Many observers supplied surprisingly good descriptions of the cougar. The following two reports, for example, are typical of many in our files: Murray Thompson, describing an animal he observed in Riding Mountain National Park in midafternoon in August 1972, wrote as follows: "The animal appeared to be tawny brown or light brown, about 4.5 to 5 feet [1.4–1.5 m] long, with a long, long tail like a piece of heavy rope. It had heavy limbs and large paddy feet, and its head appeared about two sizes too small for its body. The animal was seen walking down the road, then it crossed a ditch and disappeared into the bush. It seemed to pay little attention to the car."

In September 1972, RCMP Constable John Ireland noticed a road-killed deer in the ditch while he was on patrol on Highway 59 at Birds Hill Park, just 13 km northeast of Winnipeg. Returning at 0200 hours, he observed a cougar standing over the deer only 5 m away — so close that the whiskers on the cat's upper lip were clearly visible. Constable Ireland guessed the weight of the cougar to be about 35 kg. The cat looked into the headlights for several minutes before it ran a few metres, then came back and tried to drag the deer away. After two attempts failed, it ran off into the bush. The following morning the deer was found where it had been dragged 70 m into the bush; it was partly eaten around the rib cage and was covered with leaves — typical cougar signs. By the next day the deer had been all eaten except the vertebral column, head, legs, and skin.

Cougars Killed in Manitoba

On the night of 25 December 1973, three men investigated a commotion caused by a barking dog and disturbed cattle in the farmyard of William Kowalke at Stead, 56 km northeast of Winnipeg. A large animal was spotted with the flashlight and, believing it to be a wolf intent on the livestock, the men shot what turned out to be an adult cougar. The specimen was eventually obtained by the Manitoba Museum of Man and Nature (Cat. No. 4725), and is the first confirmed record of the cougar in Manitoba. The animal was a thin, 2-year-old male (aged by M. G. Hornocker, University of Idaho), measur-

ing as follows: total length, 2108 mm; tail length, 800 mm; hind foot, 292 mm; ear, 95 mm; testes length, 25 mm; weight, 43 kg. Male cougars (*F. c. missoulensis*) from western Canada average 73 kg and 2413 mm in total length (Cowan and Guiguet 1956).

There may have been at least 14 other cougars killed in Manitoba since 1879 (Table 1), but none has been substantiated by a museum specimen. A mounted cougar in the J. B. Hales Museum in Brandon may be the animal that was shot 19 km southeast of Brandon in the early 1920s, but this has not yet been proved. The following cougar kills are listed according to date: Pembina Hills (1879); "Plum Coulee in the Souris Country" [probably Plum Creek] (1887); Birtle (about 1895); Makinak (1901–1902); Elphinstone (1904); Brandon (two killed in 1904, skins on exhibit in general store but now lost); Duck Mountain ("early days"); Little Souris River, 19 km SE Brandon (early 1920s); Birtle (1922); Alexander (1926); Pendenis, 15 km N, 16 km W Brandon (early 1930s, skin exhibited in general store); Souris River Bend area, about 6 km N, 3 km E Margaret (1936–1937); 3 km N, 15 km W Hadashville (1969); 15 km S, 5 km E Stead (1973).

Season and Time of Sightings

Sightings were recorded from every month, and 220 could be assigned to particular seasons as follows: 40%, summer (June to August); 33%, autumn (September to November); 14%, winter (December to February); 13%, spring (March to May). These results are expected, since summer and autumn are the seasons when people spend the most time travelling on back roads and working on the land. In New Brunswick, Wright (1959) also reported sightings during every month, with 71% observed from June to November, compared to 73% in this study.

The exact time of sighting was recorded in 86 cases. Cougars were seen during every hour of the day and night; from 2100 hours to 0600 hours (sun generally at or below the horizon) there were only one to four reports each hour, whereas the peak periods were 1100 hours and 1600 hours (nine reports each) and 0800 hours (seven). There were 26 (32%) reports from 0700 to 1100 hours and 42 (50%) from 1400 to 2000 hours. Cougar activity periods vary according to prey

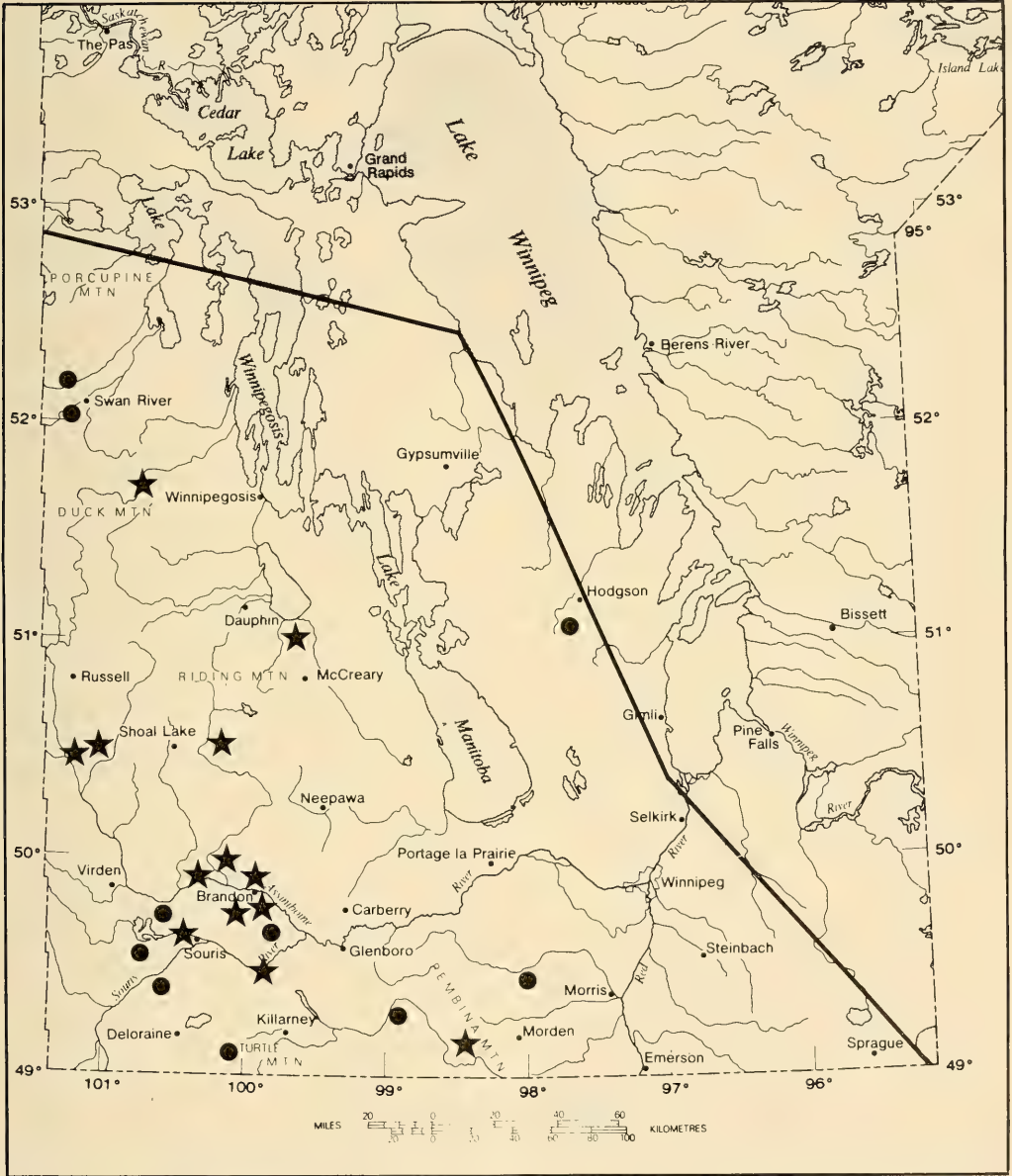


FIGURE 1. Map of southern Manitoba showing the maximum distribution of mule deer and American elk (solid line) (after Seton 1909), and cougar sightings (dots) and reported kills (stars) prior to 1940.

activity, and although most hunting is done at night, cougars have also been known to kill big game in the evening and midmorning (Seidensticker et al. 1973).

Sightings of Pairs and Young

The cougar may give birth to from one to six cubs at any time of the year, but breeds only once every two or three years. Young remain with the mother until almost full grown at about 2 years of age. Adults are typically solitary and avoid each other, except for short periods of a few weeks when two females may associate or when a male may be courting a female in heat (Seidensticker et al. 1973).

In Manitoba, sightings of two or more animals at the same time were reported on 14 occasions. Four cases involved pairs of adults, or adults and large young not distinguished as such; three cases of adult(s) and young (two adults and one young, two adults and five young, one adult and one young); three cases of an adult with cubs (twice of one adult and two cubs, one adult with one cub); two cases of two young alone; two cases of cubs alone (four cubs, two cubs); and two instances when single young cougars were observed, one of which was treed by dogs and then shot. Some of these observations lasted many minutes, with cougars running or walking across open fields, jumping over fences, or climbing into trees. Three reports of paired adult(s) and/or young were made independently by different people in the same vicinity and season.

Vocalization

In the present investigation, loud cougar calls were described in 15 reports, including four while the animal was in full view, and a cougar was seen in the area in eight of the remaining 11 cases.

A difference of opinion has existed among cougar experts as to whether the cougar emits a loud scream. Some observers (e.g., Seidensticker et al. 1973) admit hearing close-range vocalizations, but never roaring and screaming such as is abundantly described in the literature (Young and Goldman 1946; Barnes 1960). Although calls of bobcats (*Lynx rufus*) and owls have probably been ascribed incorrectly to cougars on some occasions, there is no doubt

that cougars are capable of producing terrifying calls, since they have been observed screaming in the wild and in captivity. It appears that cougars are rather silent except at mating time (Seton 1925; Wright 1959), and this may partly account for the fact that cougars are heard in one region but not in another.

Behavior

A peculiar aspect of cougar behavior, pointed out repeatedly in these reports as well as in the literature, is its indifference to being observed from a distance by people on foot or in motor vehicles. Cougars often permitted the approach of a car to within 10 to 100 m before walking leisurely or bounding to the nearest cover. The following case illustrates how bold the cougar may be. On 30 June 1974, at 1400 hours, Tim Sims was cultivating a field near Snowflake, Manitoba, when a cougar came out 400 m from the bush and lay down in a fresh furrow, perhaps to escape flies. Sims watched the animal for an hour as he made several rounds of the field, once passing within 12 m (close enough to see the cougar curl its lips and snarl). It did not appear to be frightened. Sims had seen the same animal in this field 3 days earlier and described it as brown, 0.8 m in height, 2.7 m from nose to tip of tail, tail about 0.6 m with a dark tip. On 8 August Mr. Sim's son saw a cougar with three cubs on the same land.

Food Habits

Cougars were seen stalking, chasing, or eating a variety of prey species, and were implicated (by nearby sightings, screams, tracks) in many others. Attacks (prey killed, wounded, or fleeing) were reported on cattle (13 cases), white-tailed deer (*Odocoileus virginianus*) (9), horse (3), snowshoe hare (*Lepus americanus*) (3), chicken and turkey (2), Mallard (*Anas platyrhynchos*) (1), hog (2), sheep (1), moose (*Alces alces*) (1), Formosan deer (1), dog (2), fisher (*Martes pennanti*) (1), and man (1 possible fatality). Cougars were seen stalking the following: cattle (3 cases), white-tailed deer (3), beaver (*Castor canadensis*) (1), pheasants (*Phasianus colchicus*) (1), and ravens (*Corvus corax*) scavenging on a muskrat (*Ondatra zibethicus*) carcass (1). Cougars were seen scavenging on a white-tailed deer carcass, a trapper's cache of

carcasses, a trapline (tracks and other sign indicated scavenging on a snared snowshoe hare, and killing and eating a fisher caught in a trap), and in a refuse dump. There were three instances of cougars observed drinking.

The Stead cougar had striped skunk (*Mephitis mephitis*) hairs in the digestive tract, and porcupine (*Erethizon dorsatum*) quills in the muscles of the forearms and shoulder regions. Traces of both species are often found in scats of cougars, and porcupines appear to be favored prey (Young and Goldman 1946; Wright 1959; Barnes 1960).

One report is of exceptional interest. In the summer of 1972, Walter Larocque herded 32 horses into an old pasture surrounded by bush at The Pas. In an abandoned house on the site, he found moose droppings all over the floor and blood on the door jamb, and concluded the moose had been chased into the house by some animal. One month later he noticed that two horses were missing, and the depredations continued until a total of six mares and one colt had been killed and eaten. The carcasses were found in the bush with all the meat stripped from the bones. It appeared that attacks were launched from a big elm tree that leaned over a path taken by the horses. The horses were herded into a wire corral and when two men went to check them the following morning, they had broken out. The men went to the north end of the pasture and met the horses on the run, followed closely by two tan-colored cougars which came to a halt, their "tongues sticking out of their mouths" from exhaustion of the chase. The larger cat crouched and crawled within 30 m before the men backed away. The horses were gathered and removed from the pasture. Horses, particularly colts, appear to be a favorite prey of the cougar; the large, nearby race of cougar formerly inhabiting North Dakota, *F.c. hipposlestes*, was named for this reputation as a "horse killer."

Because many livestock losses go unreported and government field staff presently lack experience in identifying cougar kills or damage, there may be a larger incidence of cougar predation on livestock than is presently known.

There is a single reported case of a cougar stalking people in Manitoba, which ended in tragedy. The following account was published by V. W. Jackson (a University of Manitoba

zoologist) in the *Winnipeg Tribune* (14 February 1942): "Twenty years ago [1922] a mountain lion attacked a boy and a girl at Birtle, Man., killing the latter. When shot it was found to be blind and half-starved." A search for additional information on this case, including a local history of the area (Abra 1974), produced no substantiating evidence.

Habitat and Distribution of the Cougar and its Prey in Manitoba

Remarks on habitat in 255 reports were grouped as follows: 40% "wilderness" (true wilderness and heavily wooded regions with few roads or human habitations), 30% "mixed land" (agricultural lands and towns interspersed with large tracts of forest), and 30% "farmland" (cropland and pasture with forest cover restricted to woodlots and river valleys).

The pre-1940 records (Figure 1) cover an area of about 87 000 km² and are restricted to the grassland region and the aspen-oak transition (now largely farmland and mixed land) in extreme southwestern Manitoba. From 1941 to 1975 the cougar appears to have extended its range (Figure 2) northward into the boreal forest region and eastward into the Great Lakes - St. Lawrence forest transition (Figure 3). The species now inhabits an area of about 200 000 km² in the southern half of the province, more than twice its apparent former range.

Although the cougar accepts an extremely wide variety of prey species (e.g., mice, fish, grasshoppers, small birds, etc.), its residence in an area is still dependent on big game, particularly deer (Barnes 1960). "The range of the panther [cougar] has always coincided with that of the deer, and as the deer have flowed back over the eastern ranges, so has the panther returned to many of its old haunts" (Wright 1959).

In early historic times southern Manitoba supported abundant mule deer (*Odocoileus hemionus*), American elk (*Cervus elaphus*), moose, caribou (*Rangifer tarandus*), pronghorn (*Antilocapra americana*), and American bison (*Bison bison*). Rather surprisingly, of these species, only mule deer and elk have been found to play a role in the cougar's diet. Reported attacks or predation on the other four species are completely absent or restricted to a few isolated

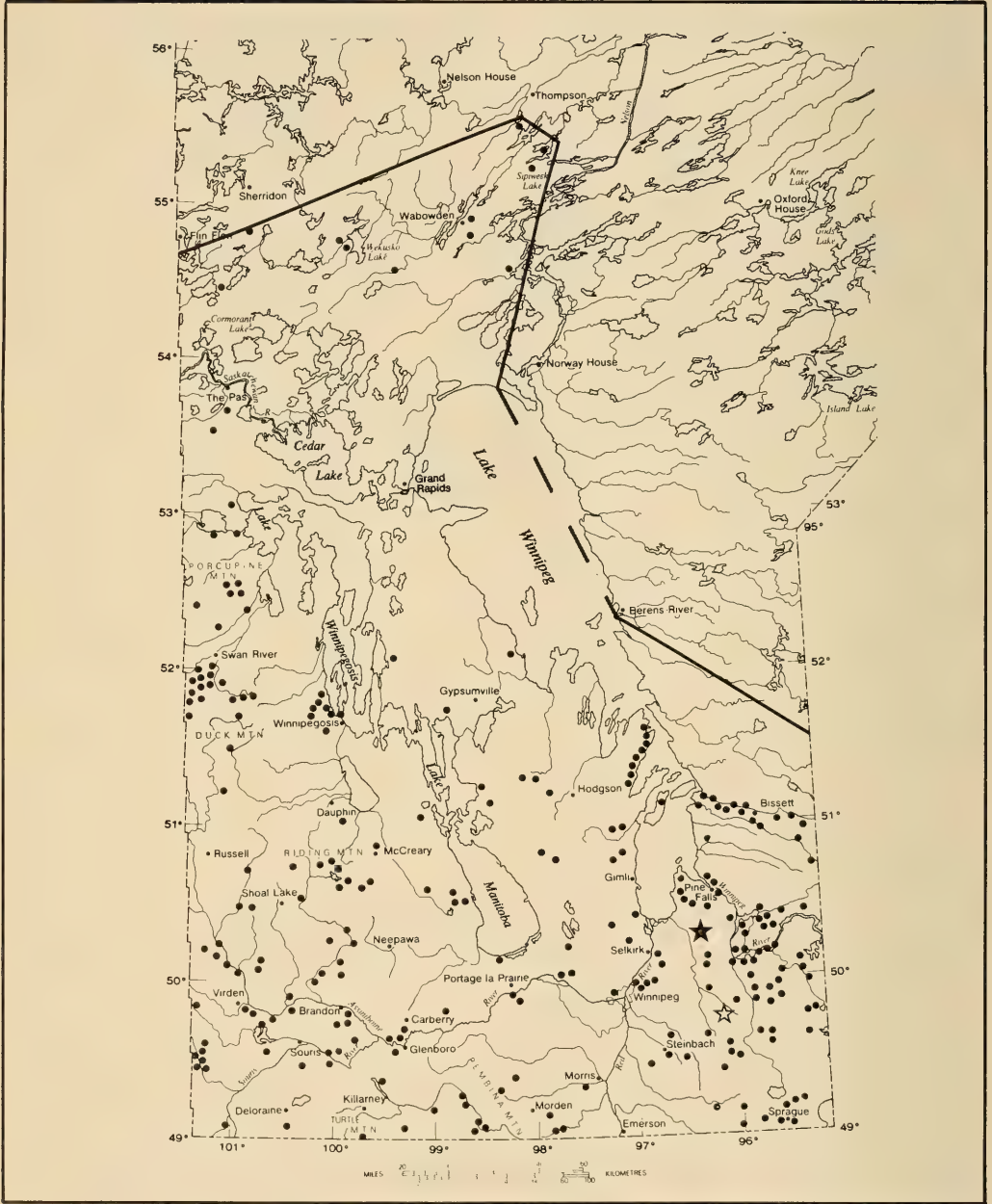


FIGURE 2. Map of southern Manitoba showing the maximum distribution of white-tailed deer (line) and cougar sightings (dots) from 1941 to 1975. The hollow star indicates the location of the 1969 cougar kill, and the solid star, the Stead specimen killed in 1973.

observations (Young and Goldman 1946; Barnes 1960).

Mule deer and elk recovered from overexploitation of the 1870s and 1880s in Manitoba, and both became numerous throughout the grassland and aspen-oak transition at the turn of the century (Seton 1909). By the end of the 1930s, however, both species were drastically reduced to relatively isolated populations, mostly in the Interlake region between Lakes Manitoba and Winnipeg, the rugged country of the Manitoba Escarpment (Pembina Hills; Turtle, Riding, Duck, and Porcupine Mountains), and the Carberry Sandhills. Probably as a result of competition with white-tailed deer, habitat destruction, and hunting, the mule deer has now been all but extirpated in Manitoba.

At present there are six herds of elk in Manitoba, totalling 5540, of which about 55% (2300–3000 animals) inhabit Riding Mountain. The Duck Mountain herd (1500–2000 animals) and the Porcupine Mountain herd (125–150) often move back and forth from adjacent rugged hill country in Saskatchewan. The Carberry Sandhills herd numbers about 150; the Mantagao herd west of Hodgson, up to 160; and the northern Interlake herd northwest of Gypsumville, 80. All but the latter two areas are regions of concentrated cougar sightings. Figure 1 illustrates the maximum ranges of mule deer and elk in Manitoba (Seton 1909). Cougar sightings from the late 1800s to 1940 are confined to the former ranges of these big-game prey species.

The white-tailed deer invaded Manitoba from the Red River Valley of Minnesota and North Dakota around 1881 and became common in many areas by the early 1900s (Seton 1909; Criddle 1929). By the 1940s this species had completely replaced the mule deer as the common deer of the province. According to provincial wildlife biologists, light hunting pressure and ideal habitat conditions of the 1940s allowed deer populations to peak in the early 1950s, perhaps numbering close to one-quarter million animals. Typical of most species invading new range, their numbers soon leveled off and then began to recede. Continued clearing of forest for farmland, severe winter climate, and heavy hunting pressure caused a steady decline through the late 1960s, culminating in the brutal winter of 1973–1974 which left a remnant herd of

less than 50 000 animals.

Figure 2 shows the white-tailed deer's maximum distribution (far into the boreal forest), and sight records of cougars from 1941 to 1975. About 85 cougar reports are outside the cougar's former range and the pre-1940 ranges of mule deer and elk, and closely approximate the distribution of white-tailed deer. North of The Pas and Grand Rapids, deer are scarce and localized. The poor correlation in eastern Manitoba north of Bissett is probably due to the absence of roads (and hence observers) in this wilderness region, as well as to the scarcity of deer and cougar along this northern boundary of their range. In interpreting the correlations of cougar distribution with that of mule deer, elk, and white-tailed deer, it should be kept in mind that population estimates of these prey species were not well known until recently, and that there are presently many more observers in the northern parts of these ranges than in the past.

The distribution of cougar records is closely associated with hilly country (e.g., Riding Mountain) and well-forested river valleys (e.g., Assiniboine River and its tributaries), especially in the grassland region. Sightings appear to be especially numerous over the years in certain locations — the region between Swan River and Duck Mountain, Winnipegosis, Brandon, the Pine Dock road along the west shore of Lake Winnipeg, Bissett, the Winnipeg River, and Sprague — most of which offer dense forest cover and concentrations of white-tailed deer.

Status of the Cougar in Adjacent Provinces and States

Transient cougars have been known to make incredibly long journeys in search of new range. Percy and Penelope Dewar reported (*in* Gregg 1974) one travelling 64 km in one night in British Columbia. Cougars are therefore effective colonizers, but will not remain in an area for long without other cougars nearby, even though each individual is solitary (Seidensticker et al. 1973). These facts may explain why cougars are occasionally observed by a number of people in an area far from known cougar range, and then are never seen again.

Resident cougars also travel over extensive areas. Seidensticker et al. (1973) followed five cougars over a full year in Idaho and found

home ranges were from 173 to 453 km². The vegetation-terrain/prey abundance-vulnerability complex was important in determining the range of a resident's movements through the seasons.

Since many of Manitoba's cougar sightings are within the animal's range capability of Saskatchewan, North Dakota, Minnesota, and Ontario, we examined cougar records in these adjacent regions. The following reports, which

include published and unpublished accounts, probably do not present a complete picture of the species' occurrence in the Midwest (Figure 3).

Saskatchewan

There are four records of cougars killed (authenticated by specimens) during the 1900s in Saskatchewan: Fort Walsh in the Cypress Hills, 1912 (Soper 1961); Kindersley, 1939 (Clarke



FIGURE 3. Map illustrating the recent distribution of the cougar in Manitoba (hatched area), cougar reports from Saskatchewan, North Dakota, Minnesota, and Ontario (dots), and the major vegetation zones of this region.

1942); Connell Creek in the Pasquia Hills, 1948 (Beck 1958); and Cutknife, 17 November 1975 (56-kg female, specimen now in the Saskatchewan Museum of Natural History) (personal communication, F. W. Lahrman). White (1963) believed that Saskatchewan afforded suitable conditions for cougars in two areas, the semi-arid grassland and forest of the Cypress Hills in the southwest, and the heavily forested region of the Pasquia Hills in east-central Saskatchewan adjacent to the Manitoba border. He recorded more than 60 sightings in the latter region, and in a subsequent paper (1967) described at least two kills in these hills, including the 1948 record of a cougar shot while caught in a wolf trap. Riome (1973) recorded an additional 10 sightings in the Nipawin-Pasquia Hills area from 1934 to 1973. These reports tie in to numerous records within 160 km of the elevated escarpment and valleys of adjacent Manitoba.

Further south are records at Regina (Brazier 1960), Qu'Appelle Valley north of Wolseley (White 1967), and four separate sightings including an adult and cubs, between 1970 and 1972 at Antler on the Saskatchewan border (White 1973). These latter sightings were within 16 km of six sightings in Manitoba during the years 1966, 1967, 1970, 1972–1974, and probably represent the same animals.

North Dakota

C. R. Grondahl (personal communication 1974), of the North Dakota Game and Fish Department, mentioned that an average of six reports of cougars are received per year, mostly from the western and northwestern parts of the State, remote areas with good populations of mule and white-tailed deer as well as domestic cattle.

The most recent authenticated cougar kills were reported by Bach (1943) in 1902, 40 km down the Missouri River from Williston: one was shot, and a second adult and a subadult were trapped. In the northern half of the state, files of the Game and Fish Department record sightings at Watford City (1965), Pick City (1959), Velva (1962), two in the Fort Totten Indian Reservation (both in 1959), and three in nearby areas — Maddock (1959), Grace City (1959), and Cooperstown (1960). One final sighting came from Walhalla (1969), reported by Paul Crary

(personal communication 1974). These records are within 8 to 190 km of the Manitoba border.

Minnesota

No cougar is known to have been killed in Minnesota in the 1900s, but Bue and Stenlund (1952) stated that there are many sightings which seem authentic. "The observations came from two general regions, the northeastern part of the state [heavily forested], and agricultural southwestern Minnesota." These northeastern sightings plus additional ones listed by William H. Longley (personal communication 1974 and 1975, including list supplied by Patrick Karns in 1964) of the Minnesota Department of Natural Resources, may be summarized as follows: one sighting in Koochiching County (1950), 17 in St. Louis County (1945–1974), nine in Lake County (1948–1962). These records come from the hilly and well forested region between Lake Superior and Manitoba, and range within 190 to 360 km of the border. About 200 km south of Sprague, Manitoba are three records from central Minnesota: Cass Lake, Cass County (1950); Itasca State Park, Clearwater County (1971); and Many Point Lake, Becker County (1956).

Closer to Manitoba are these: a sighting at Williams in 1954 (Magnus 1956), and two 1974 sightings at Salol and Northwest Angle (W. S. Adams, personal communication 1974). The last two records are both within 40 km of Sprague, Manitoba, and quite likely represent the same individual(s) seen around Sprague on six occasions from 1973 to 1975.

Ontario

No cougar is known to have been killed in Ontario during the present century, but there are numerous sightings during the last 22 years in northwestern Ontario, just north of Lake Superior. Dear (1955) mentions four records in the Thunder Bay area during 1953–1954. In 1966, C. H. D. Clarke, Chief of the Ontario Fish and Wildlife Branch, was quoted by Wright (1972, p. 96): "The other area [in Ontario] for which I give credence to reports [of cougars] is on the Manitoba boundary."

Most of the following records from Ontario were supplied by Ken J. Chambers of the Ontario Ministry of Natural Resources. In the Kenora District are sightings at Camp Robinson

(1959), Contact Bay south of Dryden (1975), four places near Watcomb (1966–1971), and 10 around Kenora (1961–1974). These Kenora-area reports are within 16 to 70 km of Manitoba, and likely represent the same cougar population occupying the Winnipeg River drainage and, in particular, the Whiteshell Provincial Park region of Manitoba where there are numerous sightings. The Stead, Manitoba cougar was killed only 82 km from the Ontario border.

Farther south, in the Rainy River District, are the following: a single 1965 record at Atikokan and a cluster of five others between Fort Frances and Lake of the Woods (1966–1972), 80 to 130 km from Manitoba and just across the international boundary from the numerous records in Minnesota.

Geographic Affinities of the Stead Cougar

Though one specimen is insufficient to make a definite subspecific determination of the local populations, it does shed some light on the geographic affinities of Manitoba cougars. Four races have been described from regions adjacent to the province. *Felis concolor cougar* occupied the northeastern quarter of the range in North America (from Wisconsin eastward) and was long thought to be extinct. But, it has survived in New Brunswick and possibly in other areas as well, and appears to be reinvading former territory (Wright 1972).

An extinct race, *F. c. schorgeri*, was described from central North America (Kansas to Minnesota) on the basis of a 100-year-old mounted specimen and two other skulls. The lack of specimens has prevented a satisfactory study of this race's taxonomic features or its former range. Recent surveys from the region have not used the name *schorgeri* for the race formerly occurring there (Jones 1964 (Nebraska)), or have accepted it with strong reservations (Bowles 1975 (Iowa)).

Felis c. hipolestes occurs to the southwest of Manitoba as far as the Rocky Mountains of Utah and Colorado. The closest specimen to Manitoba taken recently was one in the Black Hills of South Dakota in 1958, where the species remains an uncommon inhabitant of this rugged and remote area (Turner 1974). *Felis c. missoulensis* is a western race ranging from British Columbia to Saskatchewan and adjacent states.

The Stead specimen was sent to the Mammal Section of the National Museum of Natural History, Washington, D.C., and Wildlife Biologist A. L. Gardner returned the following identification: "We have examined your specimen of *Felis concolor* and have directly compared it with specimens of *F. concolor missoulensis*, *F. concolor hipolestes*, and *F. concolor cougar*. In our opinion, your specimen is much closer to *F. concolor missoulensis* than it is to any of the other named forms. The broadly flaring zygomatic arches, the large auditory bullae, large skull, and the color pattern of the skin are characters that are found in *F. c. missoulensis* but are not matched in this combination in the other named subspecies." Whether this race originally inhabited or recently invaded Manitoba is of course not known without earlier comparative specimens.

Discussion

The cougar has been characterized as a shy, secretive creature, and many outdoorsmen have spent a lifetime in the western mountains of North America without ever seeing a cougar that was not treed by dogs. In the Rocky Mountains of Idaho, Seidensticker et al. (1973) seldom saw an animal while he was radio-tracking; even at 180 m cougars sneaked away or froze until the investigators passed. Cougars did not avoid the sign of man, but made short-term shifts in their home ranges, depending on the intensity of human disturbance. Conversely, the literature on cougars is full of accounts describing cougar sightings; indeed, most of what is known about this animal comes from such chance encounters.

Several explanations are possible for the large numbers of Manitoba observations. For decades cougars on the western open range and in the mountains were hunted under the bounty system; only recently have they been afforded relief through management as a big-game animal. Even today, only Florida, New Hampshire, New Brunswick, and Manitoba offer this species complete protection. It is possible that individuals from the western regions may be more secretive than their counterparts in areas like Manitoba where they are seldom pursued by man or dogs.

Thousands of kilometres of backroads (many new) with limited traffic in wilderness and mixed

lands of Manitoba offer cougars easy travel routes and excellent hunting grounds for the deer that are also attracted to roadsides (e.g., six reports on file were of cougars in active pursuit of deer along roads). More people travelling on an ever-expanding network of backroads increases the probability of such a rare event as sighting a cougar. In agricultural regions, cougars crossing flat open areas from one woodlot to another may be spotted from a long distance (particularly transients traversing unknown lands), unlike in rolling or mountainous country where visibility is more restricted.

During the 1970s, over 150 cougar sightings were reported in Manitoba. This should not be interpreted as representing 150 different cougars, since it appears that in many cases the same individual or family was observed a number of times. For example, within 40 km south of Swan River, cougars were seen by different people on seven occasions from the summer of 1971 to the fall of 1972, two instances involving an adult with two cubs.

Though the availability of specific prey species has changed in the last 60 years (mule deer and elk to white-tailed deer), there has been no period, perhaps with the exception of the last few years, when there existed a shortage of important wild prey, not to mention the continual easy access to domestic livestock. Abundant food and cover might imply relatively stable numbers of cougars per unit area in southern Manitoba during this century. The influx of white-tailed deer, however, throughout the former range of mule deer and elk, and far into the boreal forest, apparently has allowed the cougar to expand its distribution to perhaps more than twice its pre-1940 range. In the last several decades the cougar population in Manitoba has probably been larger than at any other time, and it may still be expanding at some localities. This hypothesis agrees with White's (1967) view that the turning point in the status of the cougar in Saskatchewan was in the late 1940s, when it changed from being an extremely rare animal and began expanding its range. Our estimate of recent (1970s) numbers of cougars in Manitoba is about 50, based on the wide distribution of reports of single animals and family units. The presence of females with young confirms the existence of a resident population, since only after establishment of a

home range does the cougar end its transient phase and enter the reproductive phase of its life (Seidensticker et al. 1973).

The decline of the deer herds in Manitoba, particularly in the 1970s, to perhaps only 20% of their peak abundance in the 1950s, must have affected cougar numbers and movements. The great increase in cougar sightings in recent years may partly reflect this carnivore's wider forays in search of its favorite prey, and its attraction to livestock. The continued existence of cougars in Manitoba, as elsewhere, is intricately bound to the proper management of white-tailed deer and the maintenance of suitable habitat.

The cougar was given protection in Manitoba as a rare animal through a regulation to the Wildlife Act passed on 7 January 1974. The Regulation states: "Except under authority of a permit issued by the Minister, no person shall hunt, kill, take or capture a cougar." Moreover, a person accidentally trapping a cougar must report to provincial wildlife authorities and surrender the animal since, under The Wildlife Act, the carcass is Crown property. The cougar may, however, still be taken by a farmer or stockman to protect his animals if it can be shown that the animal has actually endangered livestock.

Reports from certain western and south-western states show an upsurge in known populations of cougars, e.g., they have doubled in California in the past decade (Williamson 1973), and there is also a renewed interest by resource agencies in determining the status and ecology of this species. In Manitoba, limited steps are now being taken to attempt the capture and radio-tagging of cougars. The results of the present study will hopefully provide a further stimulus to individuals and wildlife agencies in other regions, especially where the cougar is not well known, to investigate and record observations of what Young and Goldman (1946) called, this "mysterious American cat."

Acknowledgments

Almost all that is known about the cougar in Manitoba is based on observations made through accidental encounters by a large number of persons. We are indebted to these people, and others who directed our attention to them, for providing the basis of this report.

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Changes in Small Mammal Populations after Clearcutting of Northern Ontario Black Spruce Forest

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Abstract. Changes in small mammal populations on upland black spruce (*Picea mariana*) clearcuts near Manitouwadge, Ontario, were monitored between 1973 and 1975 by live-trapping. Additional clearcuts and uncut stands were sampled by dead-trapping in September 1975. The September density of mice and voles was similar during the first, second, and third year after clearcutting (13.0/ha, 11.6/ha, and 10.0/ha, respectively). Red-backed voles (*Clethrionomys gapperi*), likely common in uncut stands but increased on clearcuts until they predominated in the small mammal community by the end of the second harvest, and then declined markedly to rare status. Conversely, deer mice (*Peromyscus maniculatus*) likely were scarce in uncut stands but increased on clearcuts until they predominated in the small mammal community by the end of the second summer after cutting. For less common species clearcut and uncut stands were compared. Meadow voles (*Microtus pennsylvanicus*) were more common on clearcuts than in uncut stands while the converse was true for rock voles (*Microtus chrotorrhinus*). Bog lemmings (*Synaptomys cooperi*) were taken only in uncut stands while heather voles (*Phenacomys intermedius*) and least chipmunks (*Eutamias minimus*) were captured only on clearcuts. Clearcutting of upland black spruce forest produced a dramatic change in the composition of the small mammal community but may have caused little change in density.

Despite the facts that millions of acres of timber are clearcut annually in North America and that small mammals often play an important role in the successful regeneration of forests on clearcuts (see Pank 1974), relatively few studies have been conducted on the effects of timber harvest on small mammal communities. Post-cutting changes have been followed in hardwood forests in New York (Krull 1970) and New Hampshire (Lovejoy 1975), jack pine (*Pinus banksiana*) forests in Minnesota (Ahlgren 1966) and Manitoba (Sims and Buckner 1973), and Douglas fir (*Pseudotsuga menziesii*) forests in California (Tevis 1956) and Oregon (Gashwiler 1959, 1970b; Hoooven 1969), but the boreal forest, the backbone of the Canadian paper industry, has been largely neglected.

Although there has been a general lack of success with direct seeding as a means of regenerating forests in Canada, the technique offers great potential (see Cayford 1974). The Canadian Forestry Service began investigations of aspects of direct seeding on upland black spruce forests in northern Ontario in 1971 (Fraser 1975; Winston 1975) and requested that the Canadian Wildlife Service carry out co-

operative studies of small mammals on the same sites. This is the initial publication of the small mammal investigations.

The study area was located (49°18' N, 85°29' W) in the Central Plateau Region (B.8) of the Boreal Forest (Rowe 1972) about 32 km northeast of Manitouwadge, Ontario, on the Ontario Paper Company lease. The area is underlain by granite bedrock with pockets of sand and gravel, and soils are generally very thin. Before harvest, upland sites in the area supported mature stands of black spruce (*Picea mariana*) with a small component of jack pine, paper-birch (*Betula papyrifera*), and aspen (*Populus tremuloides*). Dry knolls supported mixed stands of aspen, paper-birch, white spruce (*Picea glauca*), and balsam fir (*Abies balsamea*), while wet lowland sites supported stands of black spruce with a small component of white cedar (*Thuja occidentalis*). The conifers were selectively harvested from the mixed stands leaving aspen, paper-birch, and a thick shrub layer. Some of the lowland sites remained uncut, although others were clearcut except for the cedar. One portion of the study area (Live-Trap Plot 1) (Figure 1) was clearcut in the fall of 1972,

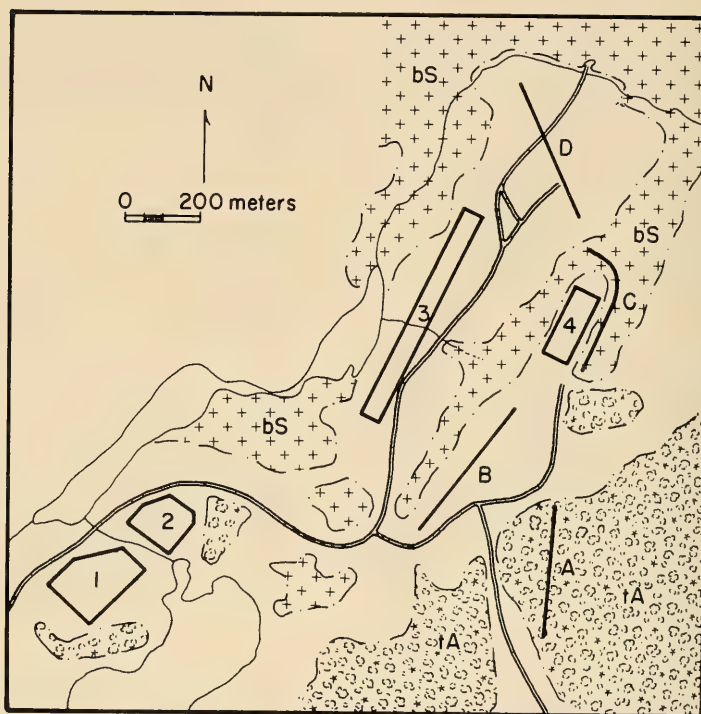


FIGURE 1. Map of Manitouwadge, Ontario, study area showing location of live-trap plots (1, 2, 3, 4) and dead-trap lines (A, B, C, D). Note location of clearcuts, uncut black spruce stands (bs), and selective cuts with residual aspen (tA).

and the remainder of the clearcuts and selective cuts in the study area were harvested in the spring and early summer of 1973. All clearcuts were cut by tree-length harvesting methods. Some were scarified using small flanged barrels and spiked anchor chains and subsequently seeded to black spruce.

Methods

Four live-trap plots were established on clearcuts on upland black spruce sites (Figure 1). Plots 1 (2.39 ha, 161 traps) and 2 (1.49 ha, 100 traps) were established in late August 1973, and Plots 3 (2.91 ha, 196 traps) and 4 (1.43 ha, 96 traps) were established in late August 1974. All plots were established immediately after scarification. Trapping points on the plots were 12.2 m apart both within and between rows. A single live-trap was placed within 1.5 m of each trapping point and was covered with a rectangular piece of plywood or dry *Sphagnum* moss and litter. Sherman live-traps were used in

1973 and both Sherman and Longworth live-traps in 1974 and 1975. Traps were baited with a mixture of ground beef suet, raisins, walnuts, peanut butter, oatmeal, and oil of aniseed. A thin slice of apple for moisture and a small handful of terylene fiberfill for bedding were placed in each trap. All traps were checked morning and evening for 10 days, and all newly captured animals except shrews were tagged in each ear with numbered fingerling tags. Shrews were marked with a numbered leg band in 1973 and were color-coded with felt-tipped marking pens in subsequent years. The plots were trapped during the following periods: 1973—Plots 1 and 2, 28 August–7 September; 1974—Plot 1, 2–12 July; Plots 1 and 2, 11–21 September; Plots 3 and 4, 28 August–7 September; 1975—Plots 1 and 2, 3–13 July, 3–13 September; Plots 3 and 4, 15–25 July, 23 August–2 September.

Four dead-trap lines, each consisting of pairs of Museum Special traps set at approximately 15-m intervals and baited with the same bait

mixture as the live-traps, were run 9–12 September 1975 (Figure 1). Each line was run for 72 h and was checked once every 24 h. Line A (46 traps) was set on a dry upland knoll from which the softwood component had been selectively cut leaving only aspen, paper-birch, some young white spruce and balsam fir, and a thick shrub layer. Line B (54 traps) was set in a black spruce clearcut which was scarified at the same time as Plots 3 and 4 but was on a slightly wetter site. Line C (50 traps) was set in mature uncut black spruce forest, and ran from an upland site down to a lowland site. Line D (50 traps) was set in an upland black spruce clearcut which was not scarified.

Owing to the difficulties in determining densities of small mammals (Krebs and Myers 1974), only a simple estimate of density was calculated from the live-trap data; the total number of individuals captured during a 10-day trapping period was divided by the area of the plot. Because of animal movement into the grid the density is considered to be a maximum figure.

The field work was carried out by several individuals: September 1973—A. Radvanyi, J. Shoup; July 1974—E. Achtemichuk, G. Tessier; September 1974—E. Achtemichuk, J. Shoup; July 1975—D. Fillman, G. Tessier; September 1975—D. Fillman, A. Martell.

Results

Small mammal numbers on all four live-trap plots followed a similar pattern (Table 1), and

therefore the plots will be grouped for discussion. Red-backed voles (*Clethrionomys gapperi*) predominated in the small mammal community at the end of the first summer after clearcutting (12.3/ha) and in the early part of the second summer (9.6/ha) but declined by the end of the second summer (1.6/ha) and were rare in the third summer (0.5/ha in September). Deer mice (*Peromyscus maniculatus*), on the other hand, were scarce at the end of the first summer after clearcutting (0.6/ha) but increased markedly by the end of the second summer (12.7/ha on Plots 1 and 2, and 4.7/ha on Plots 3 and 4) and remained high in the third summer (7.9/ha in September). Meadow voles (*Microtus pennsylvanicus*), and possibly other voles, and least chipmunks (*Eutamias minimus*) appeared on the plots the second summer after clearcutting and their numbers remained relatively stable through the third summer. Masked shrews (*Sorex cinereus*) were relatively uncommon on the plots at the end of the first and third summers after harvest (0.2/ha and 0.5/ha, respectively) but were abundant at the end of the second summer (5.5/ha). Excluding shrews and chipmunks, the total density of small mammals was similar at the end of the first, second, and third summers after clearcutting (13.0/ha, 11.6/ha, and 10.0/ha, respectively).

The dead-trapping disclosed marked differences between areas in the composition of small mammal communities (Table 2). The composition of the catch on the scarified clearcut was similar to that on the live-trap plots

TABLE 1—Number per hectare of small mammals on live-trap plots near Manitouwadge, Ontario

Species	Date and plot number															
	1973				1974								1975			
	September		July		September				July				September			
	1	2	1		1	2	3	4	1	2	3	4	1	2	3	4
<i>Peromyscus maniculatus</i>	—	1.3	3.4		11.3	14.1	5.2	4.2	4.2	1.3	3.1	1.4	6.7	10.1	6.5	8.4
<i>Clethrionomys gapperi</i>	10.5	14.1	9.6		2.1	1.3	1.0	2.1	—	—	—	—	—	0.7	0.3	—
<i>Phenacomys intermedius</i> ¹	—	—	—		—	—	—	—	—	—	—	—	0.4	0.7	0.3	0.7
<i>Microtus pennsylvanicus</i> ¹	—	—	2.5		0.8	1.3	2.8	—	0.8	2.7	0.7	3.5	—	1.3	3.4	—
<i>Microtus chrotorrhinus</i> ¹	—	—	—		—	—	—	—	—	—	—	—	0.4	—	—	—
Total mice and voles	10.5	15.4	15.5		14.2	16.7	9.0	6.3	5.0	4.0	3.8	4.9	7.5	12.8	10.5	9.1
<i>Sorex cinereus</i> ²	0.4	—	0.4		6.3	5.4	7.6	2.8	—	—	—	0.3	1.3	—	0.7	—
<i>Sorex fumeus</i> ³	—	—	—		—	—	—	—	—	—	—	0.7	—	—	—	—
<i>Microsorex hoyi</i> ²	—	—	—		—	—	—	—	—	—	—	—	0.8	—	—	—
<i>Blarina brevicauda</i>	—	—	—		—	—	—	—	0.4	—	—	—	0.4	0.7	—	—
<i>Eutamias minimus</i>	—	—	—		0.8	0.7	0.3	—	0.4	—	—	—	0.4	1.3	0.3	—
Grand total	10.9	15.4	15.9		21.3	22.8	16.9	9.1	5.8	4.0	4.1	5.6	10.4	14.8	11.5	9.1

¹Prior to September 1975 *M. chrotorrhinus* and *P. intermedius* may have been misidentified as *M. pennsylvanicus*.

²Prior to September 1975 *Microsorex* may have been misidentified as *Sorex cinereus*.

³Tentative identification from live specimen; prior to July 1975 *S. fumeus* and *S. arcticus* may have been misidentified as *S. cinereus*.

TABLE 2—Small mammals captured (number per 100 trap-nights) on dead-trap lines near Manitouwadge, Ontario, 9–12 September 1975

Species	Area			
	A Selective cut (138TN*)	C Mature forest (150TN)	B Scarified clearcut (162TN)	D Unscarified clearcut (150TN)
<i>Peromyscus maniculatus</i>	5.1	0.7	5.6	0.7
<i>Clethrionomys gapperi</i>	2.9	4.7	—	—
<i>Phenacomys intermedius</i>	—	—	—	1.3
<i>Synaptomys cooperi</i>	—	1.3	—	—
<i>Microtus pennsylvanicus</i>	—	—	8.0	6.0
<i>Microtus chrotorrhinus</i>	28.3	6.7	—	—
<i>Sorex cinereus</i>	—	—	0.6	—
<i>Sorex arcticus</i>	—	—	0.6	—
<i>Microsorex hoyi</i>	0.7	—	—	—
<i>Eutamias minimus</i>	—	—	—	1.3
Total	37.0	13.3	14.8	9.3

*Number of trap-nights (TN) run in each area.

except that meadow voles were more abundant, as would be expected on a wetter, grassier site. The composition of the catch on the unscarified clearcut, however, was conspicuously different from that on the other clearcuts in that deer mice were rare.

The overall abundance of small mammals in mature black spruce forest and on clearcuts was much less than that found in the selective cut in the mixed wood stand. Deer mice were scarce in mature black spruce forest but were common in the selective cut, while red-backed voles were more common in the mature forest. Meadow voles were absent in mature forest and the selective cut but were common on clearcuts, while rock voles (*Microtus chrotorrhinus*) were abundant in the selective cut and common in the mature black spruce forest but were rare on clearcuts (Tables 1 and 2). Bog lemmings (*Synaptomys cooperi*) were restricted in their distribution to uncut black spruce forest while heather voles (*Phenacomys intermedius*) and least chipmunks were captured only on clearcuts (Tables 1 and 2). Shrews may have been more common on clearcuts than in uncut stands but this is inconclusive because of the trapping methods used. Pitfall traps would probably have given better estimates of shrew abundance.

Discussion

The most noticeable change in the small

mammal community after clearcutting of up-land black spruce forest was in the composition rather than in the density. Red-backed voles likely were common in uncut stands, predominated on clearcuts through the early part of the second summer after harvest, and then declined rapidly until they were rare by the end of that summer. Conversely, deer mice likely were scarce in uncut stands, increased during the second summer after clearcutting, and predominated in the small mammal community by the end of that summer. A similar pattern of decrease in red-backed voles and increase in deer mice after clearcutting has been observed in Douglas-fir forests (Gashwiler 1959, 1970b; Hooven 1969; Tevis 1956) and in jack pine forests (Sims and Buckner 1973); the pattern was also present after fire in black spruce – jack pine – paper-birch forests in Minnesota (Krefting and Ahlgren 1974). Other studies have found that red-backed voles may remain rare or absent on clearcuts for 4 to 10 years after harvest (Gashwiler 1967, 1970a, b; Hooven 1969; Krefting and Ahlgren 1974) but become common sooner if thick groundcover becomes established (Ahlgren 1966; Lovejoy 1975). Red-backed vole microdistribution has been reported to show a strong correlation with the amount of debris cover and evergreen shrub cover (Lovejoy 1975; Miller and Getz 1972, 1973). It is likely, therefore, that it is the lack of cover that makes

clearcuts unsuitable for red-backed voles. Deer mice, on the other hand, are able to exploit the relatively barren habitat of clearcuts and either increase from the small stock remaining after clearcutting or to invade the clearcuts from surrounding habitats where they are more abundant, such as the selective cuts adjacent to the upland black spruce clearcuts.

The increase in the deer mouse population was probably a response to clearcutting rather than to the decrease in red-backed voles since no strong behavioral competitive interaction has been shown between those species (Grant 1970) and there is little overlap in food habits (Dyke 1971; Williams 1959). The unusually low numbers of deer mice on the unscarified clearcut, however, is unexplained. It suggests that where an increase in deer mice occurred it was in response to scarification. There is additional support for that suggestion: in September 1974 deer mice were more abundant on Plots 1 and 2, which had been scarified the year before, than on Plots 3 and 4, which had just been scarified. It is unlikely that the lower densities of deer mice on Plots 3 and 4 were due to the probable adverse effects of recent scarification, as red-backed vole numbers did not show a similar depression. Because Plots 1 and 2 were seeded in fall 1973 and Plots 3 and 4 in fall 1974, it might be argued that the deer mice were actually responding to seeding. But the seeds used on Plots 1 and 4 were treated with an apparently effective rodent repellent (Fraser 1975). More investigation is necessary to clarify the situation.

Meadow voles were taken only on clearcuts at least 1 year old and varied in numbers among the areas sampled. Microdistribution of meadow voles has been reported to correlate with moisture and graminoid vegetation cover (Getz 1961, 1970). It is likely, therefore, that they appear on clearcuts once sufficient cover has been established and in densities proportional to the amount of moist, graminoid cover present. Bog lemmings and heather voles also displayed narrow tolerances and were found only in their preferred habitats, moist coniferous forest and dry shrubby areas, respectively (Foster 1961; Getz 1961). The high density of shrews found on the clearcuts in September 1974 may indicate a general population peak such as has been described in other northern areas (Buckner 1966;

de Vos 1957) and is probably not a response to clearcutting. Shrew densities may have been higher on clearcuts than in uncut stands owing to the probable increase in invertebrates on clearcuts (cf. Lovejoy 1975). The great numbers of rock voles found in the selective cut and the mature black spruce stand in September 1975 is interesting. Because no trapping had been done in uncut stands in the study area previously, it is not known whether the observed abundance was 'normal' or a cyclic population 'peak,' if in fact rock voles do cycle. Also the population was found in an area where their supposed preferred or exclusive habitat, rocky outcrops and talus slopes (Burt 1957; Peterson 1966), was absent.

Clearcutting of upland black spruce forest in northern Ontario altered the environment so that clearcut sites were less desirable than uncut sites for red-backed voles, rock voles, and bog lemmings, although the opposite was true for deer mice, meadow voles, heather voles, and least chipmunks. Shrews may also have been more common on clearcuts. There appeared to be little change in overall small mammal density due to clearcutting.

The marked increase in deer mice after clearcutting is of particular interest to foresters because that species is considered a much more serious seed predator than the red-backed vole (see Pank 1974). Although there is no proof that either species is a serious predator of black spruce seeds, the initial data are suggestive (Fraser 1975). Assuming that black spruce seed predation occurs, the data presented in this paper suggest that on upland black spruce sites in northern Ontario seeding should be done as soon after clearcutting and site preparation as possible in order to minimize the chances of seed losses to deer mice. Also, spring seeding should be more successful than fall seeding, a suggestion that is substantiated by the initial studies by Fraser (1975) and by studies in other areas (Radvanyi 1970, 1971).

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Morphological Parameters and Spring Activities in a Central Ontario Population of Midland Painted Turtle, *Chrysemys picta marginata* (Agassiz)

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Abstract. *Chrysemys picta marginata* in a north-central sector of its range exhibits values for standard taxonomic characteristics that have wide individual variability. A population at Nogies Creek, Ontario did not exhibit values which might, from the literature, be expected ("typical") for this subspecies in that part of its range. Individual sizes do approach maxima for midland painted turtles. Nesting activities are described for the population. Photoperiod appears to be an instrumental guideline for timing daily and annual nesting activities. Other environmental factors may temper its effect. Turtles might locate the nest sites by a simple form of homing.

Much information has been published within the past 25 years on the midland painted turtle, *Chrysemys picta marginata* (Ernst 1971c). Despite this animal's popularity as an experimental subject, it has received geographically extensive attention only in areas of intergradation. Few data are available from any northern populations. Information on the subspecies must often be extrapolated from discussions of the species, *Chrysemys picta* (Schneider).

The present study was undertaken for the following reasons:

(1) to provide some basic morphological and observational data on *C. p. marginata* in the north-central portion of its range. These statistics can then be compared with findings of authors such as Hartman (1958), Pough and Pough (1968), and Ernst (1970a) in the eastern and southern zones of intergradation.

(2) to describe the spring activities of the midland painted turtle in this north-central study area. Sexton (1959) divided the annual activity cycle of *Chrysemys* into five seasons. This project focuses on behavior in the late vernal and early aestival periods, with the hope of delineating nesting and associated movements.

Study Area

Chrysemys p. marginata was collected at the

Nogies Creek Fish Sanctuary in Peterborough County, Ontario (Figure 1). Previously described by Crossman (1956) and Muir (1963), the sanctuary consists of a meandering 6.4-km stretch of drowned stream, the lower portion of which widens into a shallow 32.4-ha lake. Most open water is from 1.5 to 2.0 m deep although several spots drop to 5.0 m. Aquatic vegetation emerges early in June and by the end of that month has reduced the open water to a narrow channel. The surrounding land is predominately a shallow gravelly till over frequently exposed bedrock. Mixed forest lines most of the shoreline.

Nogies Creek Research Station trap-net catch records dated 1951 reveal painted turtle catches approximately similar to those of the present. Personal observations (Crossman) have recognized no major changes in turtle abundance through the ensuing 25 years. This suggests a long-standing, stable population of *C. p. marginata*. At least 20 species of fishes, 61 varieties of aquatic plants, and 2 other species of turtle, Blanding's turtle, *Emydoidea blandingi* (Holbrook), and common snapping turtle, *Chelydra s. serpentina* (Linnaeus), cohabit the sanctuary.

Materials and Methods

Between mid-May and early July of 1974 turtles were captured in trap-nets and hoop-nets

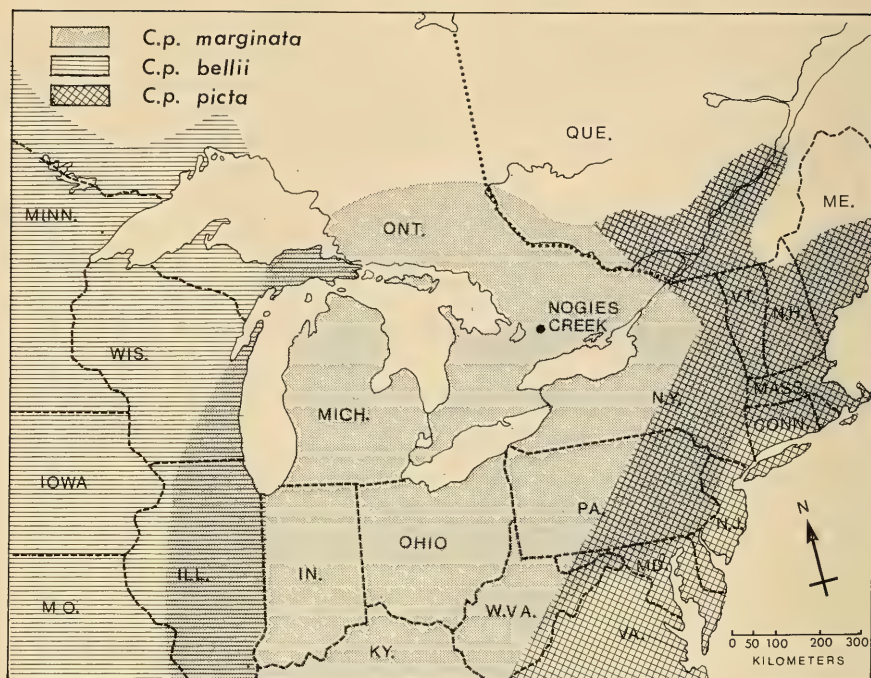


FIGURE 1. Ontario study location in the north-central portion of the range of *C. p. marginata*. Map adapted from Conant (1975). Intergradation occurs in zones of overlap.

with occasional opportunistic hand sampling. The nets were regularly relocated in a total of 25 sites within the lower sanctuary. Capture by hand was necessary only for terrestrial samples.

Carapace total length and carapace curved length were measured with a flexible metal tape rule accurate to 1.0 mm. Weight was recorded by placing the animal on its back in a plastic bucket which was then set on a hanging spring scale precise to 25 g. Sex was determined from the length of the foreclaws. In 1974 each turtle was numbered on the plastron with indelible red ink and when the first animal with an illegible number was recaptured, after approximately 2 months, trapping was discontinued. In the first 3 weeks of June 1975 turtles taken in the nets were marked and released but the main emphasis at that time was observations on shore. In 1975, numbering of individual turtles was accomplished by notching the marginals with a hacksaw blade (Cagle 1939). Each marginal had been assigned a number so that a notched

marginal, or combination of marginals, served to identify turtles in a more permanent manner than the previous year's ink markings.

The three characters used by Hartman (1958) to distinguish *C. p. marginata* from *C. p. picta* (Schneider) were measured with calipers exact to 0.01 mm. Alignment of central and lateral laminae was measured and calculated as described by Hartman (1958) and later by Pough and Pough (1968). One hundred percent disalignment describes exact alternation of the laminae as is "typical" in *C. p. marginata*, while 0% represents the linearly catenated seams "typical" in *C. p. picta*. The plastral figure, if present, was copied directly onto tracing paper to allow for later experimentation with different plastral figure measurements. Eventually figure length, greatest figure width, longest figure extension along a seam, and plastron length were measured to the nearest 0.5 mm. Figure length and greatest figure width were plotted against plastron length, and longest seam-figure

TABLE 1—Statistics relating to shell markings of *Chrysemys picta marginata* in Nogies Creek, Ontario, 1975. *n*, number in sample; \bar{x} , mean of the "characteristic" expressed as a percentage for the total of the relevant sample population; SD, standard deviation (one); SE, standard error (one); μ , population mean estimated by \bar{x} , subscript 1 represents the male sample, subscript 2 represents the female sample

Characteristic	Sample composition	<i>n</i>	\bar{x}	SD	SE	95% confidence	Test hypothesis ¹ $\mu_1 - \mu_2 = 0$
Plastral figure length/plastral length	Total sample	47	62.98	16.30	2.38	58.19–67.76	0.0555 Accept
	Males	22	64.66	8.32	1.77		
	Females	23	64.13	45.28	9.44		
Greatest plastral figure width/ greatest plastral width	Total sample	47	46.85	9.16	1.34	44.16–49.54	2.7401 Reject
	Males	22	43.00	9.70	2.01		
	Females	23	50.14	7.58	1.58		
Longest seam- figure-extension/ greatest figure width	Total sample	47	20.34	8.67	1.26	17.79–22.88	1.2951 Accept
	Males	22	19.10	6.66	1.42		
	Females	23	22.26	9.52	1.98		
Light margin/ total length	Total sample	50	1.04	0.36	0.05	0.94–1.14	1.8554 Accept
	Males	23	0.93	0.38	0.08		
	Females	26	1.13	0.35	0.07		

¹Critical value 95% confidence = 1.960.

extension against greatest figure width (see Table 1). Those ratios test the length relationships that interested Hartman (1958), the figure width characteristics that concerned Bishop and Schmidt (1931), and the figure extension traits that Carr (1952) found to be important. Hartman (1958) and Ernst (1970a) indicated a sub-specific differentiation in the width of the anterior light margin on the third lateral. This was measured. The total length (anterior to posterior) of each of the carapace and plastron was recorded. Shell abnormalities were also noted.

Observations of nesting activities were concentrated at four well used sites. A gravel road runs parallel to the west shore of Nogies Creek for a distance of 3.2 km. The turtles had to cross the road to reach three of the nesting locations and were easily seen. Observations started at 0700 hours and ended at dark since there were no references to night activity by *C. p. marginata* in the literature surveyed. In the beginning the road was traversed every half hour and observations were made on all turtles that could be located from the road. As a result it became obvious that there were daily peak periods of activity and

periods of lesser activity. Subsequently activity was monitored every half hour during the known peak periods and at hourly intervals otherwise. The duration of each observation (on one or more than one turtle) varied but the road was not left unmonitored for longer than the intervals given above. The fourth nesting location, having poor accessibility, was visited irregularly.

Date, time of day, location, identifying number, and morphological characteristics were recorded for each turtle. When an animal was found to be nesting, its activities were observed from a place of hiding or with binoculars from a distance. Measurements were made after nesting, or when the turtle was returning to the water.

Nests were measured (diameter of neck, depth of main chamber, depth to bottom of main chamber). The substrate was described, distance from shore estimated, and terrain noted. If a turtle was seen at a nest which was later covered over, the nest was unearched. From any nest with eggs, clutch size, depth to eggs, and egg size (length and width) were recorded.

Air temperature was measured daily with a maximum-minimum thermometer. Daily max-

imum and minimum air temperatures from the nearest official Climatological Station in Cobocok were obtained through the Meteorological Applications Branch of Environment Canada. The Corn Heat Units (CHU) were calculated from these (see Brown 1972). Water temperature was not considered because of an incomplete record at the sanctuary; however, the close correlation between air and water temperatures should minimize the importance of this omission (see McCombie 1959).

Measurements and Observations

Standard Measurements

A sample of 50 turtles from Nogies Creek was tested for disalignment of the lateral and central laminae seams. The mean disalignment was 86.4% with a standard deviation of 11.3 and standard error of approximately 1.6. This is in accordance with the findings of Pough and Pough (1968) and Hartman (1958), and is well above the minimum 55% disalignment set by Ernst and Ernst (1971) for the midland painted turtle. Figure 2 shows that of populations studied to date, the Nogies Creek population is

perhaps the closest to expected findings for *C. p. marginata* populations. The wide range of 70 disalignment percentage points (36–102) is partly explained by one deviant individual (36%). The next value higher than 36% was 73%.

Plastral figure measurements are summarized in Table 1. The mean value for figure length as a percentage of the plastral length is 62.9. Greatest plastral figure width averages 46.8% of the greatest plastral width. The mean value for longest seam-figure extension as a percentage of the greatest figure width is 20.3%.

Since the Nogies Creek plastral figures were all recorded on tracing paper, they can be compared to the diagrams of *C. p. marginata*, *C. p. bellii* (Gray), and an intermediate given by Bishop and Schmidt (1931). A visual inspection of their sketches reveals that in a Nogies Creek sample of 50 turtles the majority (38 or 76%) had what seems to be *C. p. marginata* plastral figures. None displayed the markings of *C. p. bellii*, but nine (18%) had intermediate characteristics.

No one has yet been able to devise a totally

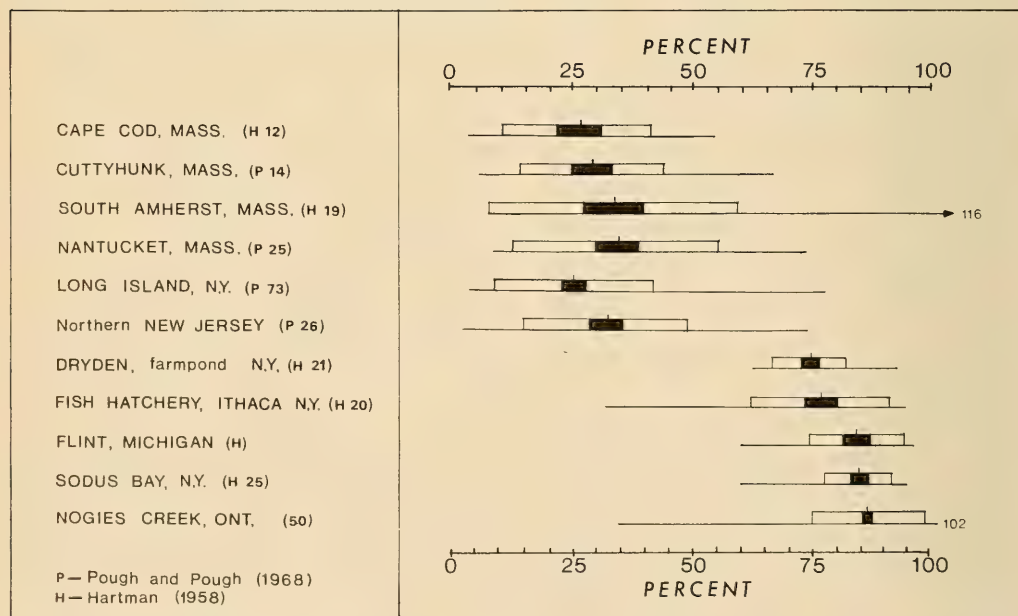


FIGURE 2. Percentage of disalignment of central and lateral seams for several populations depicting range, mean, one standard error and one standard deviation on each side of the mean.

reliable statistical method for expressing the differences between the plastral figures of the two subspecies, because of the high degree of individual variation. Bishop and Schmidt (1931) used the width of the plastral figure expressed as a percentage of the plastral width. According to their study, the mean value for *C. p. marginata* was 36%, for *C. p. bellii* 74%, and for intermediates 55%. The Nogies Creek turtles, with a value of 46.8% (Table 1) lie about halfway between the value for intermediates and that for *C. p. marginata*. Only eight (16%) individuals had plastral figures with widths less than 36% of the plastral width, and none were in excess of 74%.

Three of the Nogies Creek turtles had no plastral figure at all. This characteristic is normal in *C. p. picta*. The mean value of figure length as a percentage of plastral length for Nogies Creek turtles is 62.9% (Table 1). There are no comparable figures in the literature. Bleakney (1958) indicated two intergrade figure traits: (1) dark spots on the midline, and (2) smaller, often lighter figures, symmetrically distributed about the midline and having blurred edges. None of the Nogies Creek sample displayed dark spots on the midline and only four turtles were faint in color and had figure lengths

less than 50% that of the plastron.

The longest seam-figure extension was calculated as a percentage of the greatest figure width (20.3) with little utility. This relationship did not support the visual impression of the plastral figure as did the aforementioned comparisons involving figure length and width; however, it has been presented in Table 1 as the best measure of seam extensions. Other traits compared less successfully to longest seam-figure extension were plastral length, figure length, and greatest plastral width.

Hartman (1958) plotted the width of the light margin against carapace length. Nogies Creek painted turtles have been similarly characterized and compared with Hartman's results in Figure 3. The Ontario turtles align themselves with the New York samples of *C. p. marginata* and are clearly distinguishable from the Massachusetts intergrade population (*C. p. marginata* \times *C. p. picta*).

All three of the ventral figure relationships, and that between the light margin and carapace length, were tested for sexual dimorphism. The width of the plastral figure, when expressed as a percentage of the width of the plastron, was the only one of these characteristics having two statistically different sexual values (see Table 1).

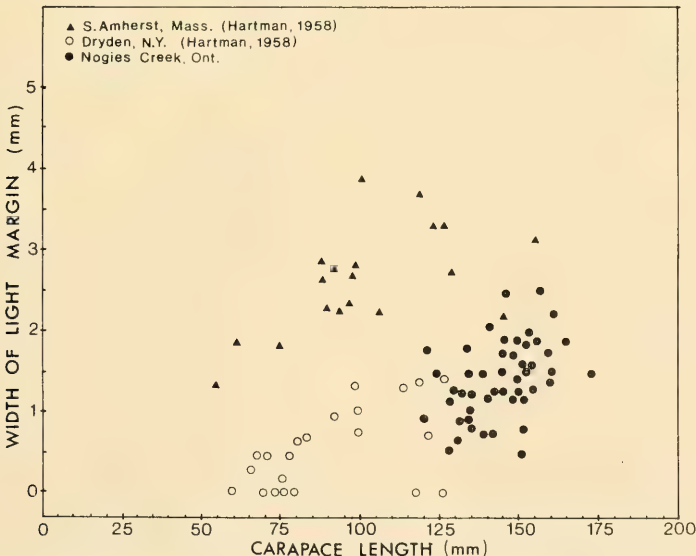


FIGURE 3. Width of the light margin of the third lateral plotted against carapace length. Adapted from Hartman (1958).

These calculations are only slightly significant (test hypothesis value = 2.74, 95% confidence = 1.96) and because of the nonsignificant values for each of the other three shell-marking characteristics, sexual dimorphism was not pursued any further.

Other Measurements and Morphometric Observations

Frequency polygons for length and weight in the sample of Nogies Creek turtles are given in Figure 4. A total of 195 turtles was captured. They ranged in length from 105 to 181 mm and in weight from 175 to 675 g. According to Ernst (1971a), male turtles in Pennsylvania usually mature at a plastral length of about 70 mm, in their fourth year, and females at approximately 100 mm, in their fifth year. If this is applied to the Ontario population it appears that netting was selective for mature painted turtles, especially since there was no problem sexing even the smallest animals. Females were larger than males.

Fifty-one turtles were examined in 1975 for the humped-back condition ("kyphosis") described by Ernst (1971b). None displayed the trait. An additional 195 turtles from 1974 were tested for deviation from a straight-line relation-

ship between the total length of the carapace and the curved length of the carapace. No obvious deviants were noted in these Nogies Creek turtles. Ernst (1971b) noted that 0.5% of his sample at the White Oak Bird Sanctuary in Pennsylvania exhibited kyphosis.

In a subsample of 51 turtles from Nogies Creek, exterior deformities were recorded; 20 (39%) had deformities of the following kinds. Plastral abnormalities were the most numerous. Ten of the 20 animals (19.5% of 51 sample turtles) had misshaped plastrons. Ernst (1971b) found only one occurrence of this peculiarity in his collection of 929 turtles. In the White Oak study, carapacial abnormalities were found on 6.2% of the deformed turtles. This variation comprised 13.7% of the Nogies Creek sample. Sixteen percent of the 51 Ontario turtles examined displayed unusual appendages. Combinations of the above deformities were not uncommon in either Ernst's or the present studies.

Spring Movements: Aquatic

Figure 5 summarizes the numbers of *C. p. marginata* captured per net, per day, in 1974. A comparison of the daily air temperatures for the same period of time, also in Figure 5, reveals a

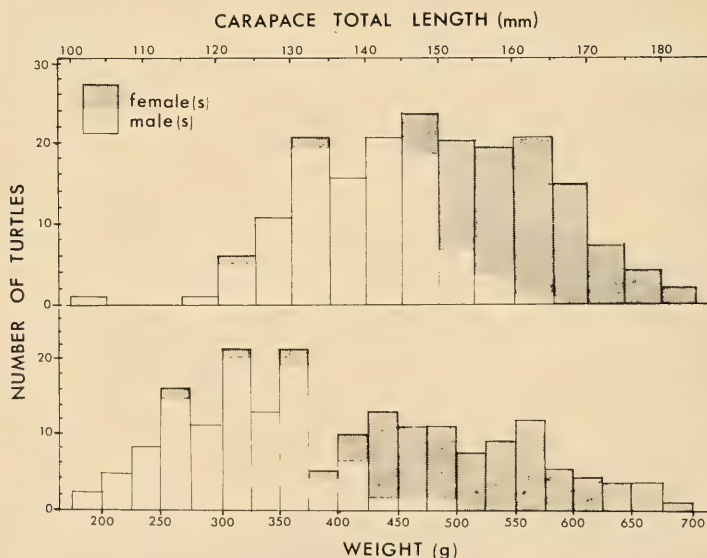


FIGURE 4. Lengths and weights of male and female *C. p. marginata* from Nogies Creek.

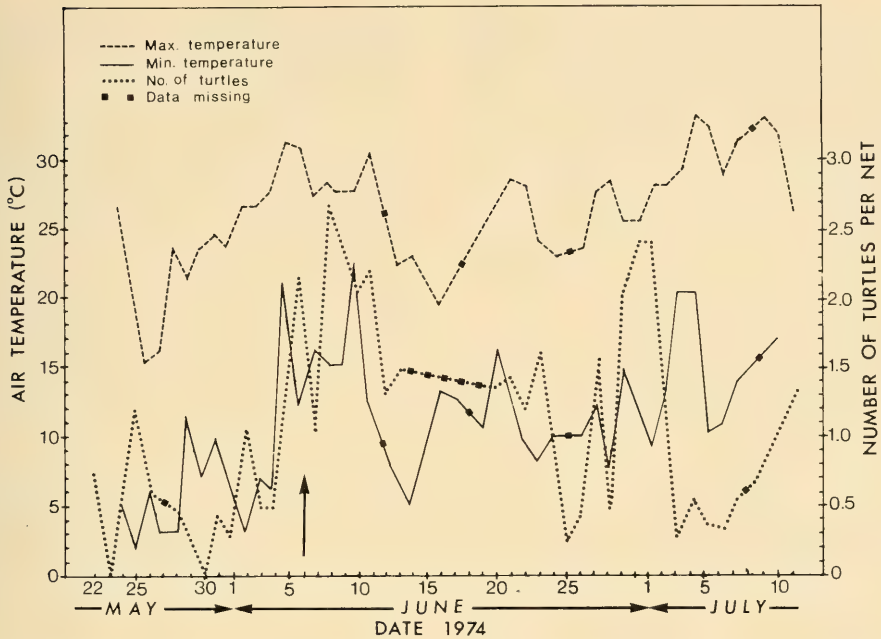


FIGURE 5. Daily maximum and minimum air temperatures plotted with the numbers of turtles caught per net, calculated per 24-h period in 1974.

direct relationship between air temperature and turtle movement reflected in the number captured. But, there often was a time lag between peaks of temperature and activity. There was also a coincidental increase in temperature and movement immediately prior to the initiation of nesting activities. Extensive cloud cover was observed (no data) to have a negative influence on turtle activity.

Turtles were first seen nesting on 6 June in 1974 and 12 June in 1975. At the initiation of nesting in 1974 approximately 515 Corn Heat Units (CHU) had accumulated since mid-April (calculated from records at a climatological station 19.3 air km to the northwest). Nesting in 1975 started when 804 CHU had been recorded.

In the aquatic netting of 1974, 174 different *C. p. marginata* were captured, measured, and returned to exactly where caught, before plastral numbering became illegible. Of these, 43 (24.7%) were recaptured, 32 (18.3%) only once, seven (4.0%) twice, two (1.1%) thrice, one 8 times, and one 10 times, for a total of 244 captures. Twenty-

six of the 43 recaptured turtles had changed position between captures.

In the total of 244 aquatic captures between 22 May and 11 July 1974 there were 159 males and 85 females; the sex ratio was 1.87:1. Because some turtles were captured more than once, actually only 174 individual *C. p. marginata* were caught in the nets. This included 104 males and 70 females for a sex ratio of 1.49:1. Single captures were recorded for 131 turtles with a 1.34:1 sex ratio. This contrasts sharply with the sex ratio of 2.07:1 for individuals displaying multiple recaptures. When the number of captures per sex are summed, regardless of the number of turtles involved, the sex ratio becomes 3.67:1.

Spring Movements: Terrestrial

All 30 terrestrial captures, involving 25 *C. p. marginata*, were females. Three of the five recaptures occurred on the day after the initial capture. These three recaptured individuals were all discovered within 5 m of the point of original

capture, one no more than 0.5 m from the first site. Another of the five recaptures was found after 2 days about 15 m from the initial location. The last was relocated 8 days later approximately 150 m from the original site.

A large number of empty nest holes was found in the most frequented nesting areas. In 1974 an unrecorded number of unmarked turtles was observed digging nests which they later abandoned as empty holes. Sometimes these contained obstacles such as rock; in others there was no apparent physical restriction.

Only three turtles were captured both in the water and on land. One had travelled 250 m from the initial site of netting to an adjacent part of the shore. It was found 100 m from the water by a sandy roadside bank.

Two turtles were discovered on land 850 m and 1075 m from the original location of capture. These represent the farthest distances travelled by any of the marked animals. The two were found within 30 m of each other at one of the most-used nesting sand banks. One had been previously captured in the water 1075 m to the north along an irregular shoreline. The other was later captured in a net 850 m to the south along a similar shore. From the creek there was no apparent visual clue to the location of the sand bank owing to the high bushes which line most of the water's edge.

Nesting Activities

Nesting behavior in painted turtles has previously been described: *C. p. marginata* (Hartweg 1944; Carr 1952), *C. picta* (Babcock 1919), *C. p. bellii* (Legler 1954; Mahmoud 1968). Although direct observations at Nogies Creek largely confirmed these other findings, three additional points were recorded. Four turtles were observed from the time of initial search for a suitable nest site to the final covering over of the eggs. Nesting behavior for an additional dozen animals was noted in part.

(1) A female *C. p. marginata* would move out of the water at a steady pace and with its head level. It would stop upon reaching denser vegetation, lift its head and remain static, or proceed erratically until a new direction was established. This behavior continued until the turtle came to a potential nesting area. Then it would lower its head until almost touching the ground and creep

ahead slowly as if sensing something. Occasionally it would scrape the ground with its claws. The site eventually was accepted or rejected.

(2) The periodic discharge of liquid from the anus during digging was described by Legler (1954). At Nogies Creek turtles measured prior to laying eggs discharged liquid, but any captured upon completion of a confirmed nesting had no liquid discharge. Turtles continued nesting activities even after discharging their liquid. Thus the liquid, which seemed to aid in digging, is probably not a necessity.

(3) When laying was completed, the female turtle would cover the nest hole using its hind legs and tamp the surface down with its plastron. One turtle was observed dragging some nearby (one shell length) loose leaves over the nest with its front legs. Nests in grass were almost indistinguishable even immediately after their formation. A rain usually obliterated all traces.

Seventeen female *C. p. marginata* were found moving on land and away from the water. They were all discovered between 1500 and 1915 hours (1640 hours mean). The duration of their activities varied from 1 to 4 h with the largest recorded capture being at 2100 hours. Turtles were located anywhere from 1 to 200 m away from the water on shore (mean 46 m). Approximately 37 nests, however, ranged between 2 and 50 m from the shoreline, averaging 20 m.

Clutch size in five nests varied from 6 to 9 eggs, with a mean of 7.2. This is within the 3 to 11 egg range listed by Carr (1952). Immediately after laying, the eggs had an average width of 18.5 mm (range 16.9 to 19.5 mm, $n = 14$) and a mean length of 30.8 mm (range 26.7 to 50.0 mm, $n = 14$). One nest examined after it was incubated for 73 days contained five apparently healthy eggs (plus four mutilated) which averaged wider but shorter than those newly laid (width: mean 20.5 mm, range 18.1 to 22.2; length: mean 29.0 mm, range 25.5 to 31.1). The comparable ranges listed by Carr (1952) are length 28.6–31.8 mm, and width 17.5–20.6 mm.

Mean nest dimensions were as follows: diameter of neck, 29.1 mm ($n = 3$); diameter of main chamber, 65.2 mm ($n = 7$); depth to eggs, 25.0 mm ($n = 1$); depth to bottom of main chamber, 70.6 mm ($n = 6$). Ernst and Barbour (1972) described nests of *C. picta* as having the

following dimensions: main chamber 65–72 mm, neck diameter 41–51 mm, and depth 99–111 mm. Most nests were situated in sandy loam, gravel, or sandy gravel. The ground was clear, or had a grass cover of up to 30 cm in height. All received the sun most of the day and there were few not on level ground or on the lower slopes of an east-facing bank. From the data of this study it is impossible to estimate nesting success. Predators were numerous, raccoons, people, and larval insects being common.

No vernal emigration as reported by Sexton (1959) was noted in Nogies Creek. Constant water levels regulated by a dam at the lower end of the sanctuary may account for this.

Discussion

Standard Measurements

Bleakney (1958) hypothesized that the northward postglacial dispersal of *C. p. bellii* and *C. p. dorsalis* (Agassiz) resulted in an intra-specific hybridization around St. Louis, Missouri. The subspecies *C. p. marginata* emerged and subsequently extended its range to its present status.

The Nogies Creek turtles clearly display carapacial disalignment and light margin width "typical" of *C. p. marginata*. The plastral figures, however, seem to be wider and perhaps longer than might be expected. This does not necessarily indicate intergrade characteristics of the north-central subspecies with another. It could be evidence of the *C. p. bellii* influence in Bleakney's postulated *C. p. bellii* × *C. p. dorsalis* origin of *C. p. marginata*. Similarly, although the lack of plastral figure or its reduced size is a trait documented in intergrade *C. p. marginata* × *C. p. picta*, its occurrence in this sample might be attributable to *C. p. dorsalis* ancestry. Plastral figures, however, possibly become fainter with age as all three turtles were large (older?). Masat and Musacchia (1965) found four electrophoretic patterns in blood serum proteins of *C. picta*. These patterns were randomly distributed among the turtles regardless of subspecies. Although this does not dispute Bleakney's theory it does suggest that a more widespread introgression could have influenced *C. p. marginata*.

The plastral figure length and width, in comparison to the respective length and width of the

plastron itself, appears to be the most readily quantifiable of the figure characteristics. But, it must be expected that of the subspecific parameters discussed herein this will be the most variable as a result of the difficulty in describing the plastral figure.

This study clearly demonstrates that even in the north-central part of its range, *C. p. marginata* displays a diversity of individual traits. The necessity of large samples for correctly describing peculiarities in the midland painted turtle is emphasized. It is probable that even in the best of samples, a statistical population of *C. p. marginata* will only approach the "typical" and defining disalignment, plastral figure dimensions, and light margin widths.

The Nogies Creek painted turtle sample was normally distributed with respect to carapace length. Individual turtles ranged in size from 103 to 181 mm. Carr (1952) described the catches of a New York study as consisting of animals ranging from 106 mm to 175 mm. He reported the largest turtle on record as being 188 mm long. Conant (1975) stated that *C. p. marginata* usually range in length from 115 to 140, the record length being 187 mm. Thus, the north-central Nogies Creek population falls within the range of carapace lengths that would be expected of *C. p. marginata*. Figure 4 reveals a difference in the distribution of turtle sizes between the male and female subsamples. This difference is worth noting, but the growth relationships and other factors which may have created it are beyond the scope of the present study.

Spring Activities

That turtles respond predictably to temperature has been indicated by several researchers. Sexton (1959) found that mass emigration of *C. p. marginata* would be initiated only when the temperature of the inlet was 8°C or higher. Ernst (1972) established the critical maximum temperatures, and the temperature below which dormancy occurred. The number of turtles caught per unit of effort in Nogies Creek oscillated with major temperature changes. Greater catches corresponded with higher temperatures but there was often a lag period between the peaks in temperature and activity. Some authors, however, have noted an acute ability to sense light.

Noble and Breslau (1938) found hatchlings were attracted to high illumination. Ortleb and Sexton (1964) discovered that *C. picta* not only responded to light but were able to discriminate between light intensities of 0.1 foot candles. Light and temperature in the natural setting are usually closely linked and their respective effects may be confused.

Legler (1954) reported that *C. p. bellii* usually nested between 1700 and 1800 hours. Mahmoud (1968) observed nesting between 0500 and 0900 hours and later between 1600 and 2300 hours. The female *C. p. marginata* at Nogies Creek commenced daily nesting activities probably no earlier than 1400 hours and ceased leaving the water by about 1800 hours. This did not vary noticeably with air temperature. The annual initiation of nesting was also precise. In 1975 it was only 6 days later than in 1974. But 1975 had a remarkably warmer spring and if temperature is instrumental in inducing nesting behavior there should have been an appropriate early start of nesting.

The uniformity of timing in daily and yearly activity would perhaps be more correctly attributed to light than temperature. Sensitivity to photoperiod would adequately explain the timing accuracy noted in this study. It would provide a much more dependable diurnal and annual clue than temperature. By having a set, safe activity period the turtles would not be fooled by short-term temperature changes when a long-term endeavor such as a summer's incubation is at stake. It is possible that unfavorable temperature may discourage a photoperiodically induced turtle if there is potential danger to the individual or activity. Nogies Creek *C. p. marginata* were also observed emerging in abnormal abundance following an afternoon shower, possibly to take advantage of the better digging conditions. Other environmental factors may occasionally override the basic photoperiodic clue.

The long distance travelled to an "ideal" nest site by some Nogies Creek turtles and the high incidence of turtles found along several exposed sand banks suggests a form of homing. Furthermore, marking turtles at aquatic capture sites revealed females as static during this their anticipated active time of the year. The ratio of males to females taken in nets favored males.

From recapture information, males are clearly more active than the females. The absence of females from the records may be normal if many female turtles were on or near shore. But in their movements to and from nesting sites they should have turned up in the netting results. This can be explained if the females are able to migrate to a chosen nesting site and return to the site of normal activity. A random net distribution would likely be sensitive to a randomly wandering population of female turtles yet could conceivably be ineffective against a directed movement.

Many authors have documented homing in *Chrysemys picta*: Cagle (1944), Williams (1952), Gould (1959), Ortleb and Sexton (1964), Emlen (1969), and Ernst (1970b). Emlen (1969) presented a strong argument for visual recognition of local topographic landmarks in orientation of *C. picta*. He pointed out Casteel's (1911) findings of good visual discrimination in the species as well as a notable long-term memory.

The long-distance travel to appropriate and hidden nesting sites described in this paper may also indicate homing, perhaps as has been hypothesized for marine turtles in the form of a return to the place of birth (Carr 1972) or as a return to a previously discovered suitable nesting location.

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Germination Requirements of Alaskan *Rosa acicularis*

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Abstract. Germination requirements of Alaskan seeds of *Rosa acicularis*, a common shrub in the boreal zone of Asia and North America, were determined from laboratory experiments and observations of germination under outdoor conditions. Germination was rapid and complete at temperatures of 5°C to 20°C after 2 months of warm stratification and 3 months of cold stratification. Cold stratification alone or with a pretreatment of concentrated H₂SO₄, resulted in slow and incomplete germination. Laboratory and outdoor experiments indicated that most *R. acicularis* seeds take 2 years to germinate. Seeds develop and mature the first growing season, warm stratify the next growing season, cold stratify the following winter, and germinate in the spring shortly after snowmelt. Suggestions are made as to the overall reproductive strategy of *R. acicularis* and the role of its germination requirements.

Rosa acicularis Lindl. (prickly rose) occurs on a broad range of sites in the boreal zone of Asia and North America (Figure 1). In Alaska this species is common in forests and is abundant as a successional species in disturbed areas. The plant is an important food source for many animals, including microtine rodents, grouse,

and snowshoe hares. Fruits are also eaten by humans and are an excellent source of vitamin C. *Rosa acicularis* has potential as a revegetation species for disturbed areas where food for wildlife and aesthetics are important considerations. Little information is available in the literature on regeneration from seed in this species; however, Babb (1959) recommended soaking seeds of *R. acicularis* in concentrated H₂SO₄ for 1 h, then cold-stratifying at 6.5°C for 3 months, but he did not report what work was done as the basis for his recommendations.

Other species of the genus *Rosa* that have been studied appear to have the same type of dormancy and similar germination requirements, although depth of dormancy varies. Temperature-zone *Rosa* species required cold stratification to break dormancy and germinated poorly or not at all when kept at warm temperatures (Blundell and Jackson 1971; Crocker and Barton 1931; Nyholm 1955; Semeniuk and Stewart 1966; Svejda 1968). Pretreatments of soaking in concentrated H₂SO₄ (Blundell and Jackson 1971; Svejda 1968; United States Forest Service 1948) or warm stratification followed by cold stratification (Bouillene-Comhaire 1970; Rowley 1956; Semeniuk and Stewart 1966; Svejda 1968) often gave higher and more rapid germination than cold stratification alone. This paper describes the germination requirements of *R. acicularis* as determined from laboratory experiments and observations of germination of seeds subjected to outdoor conditions.

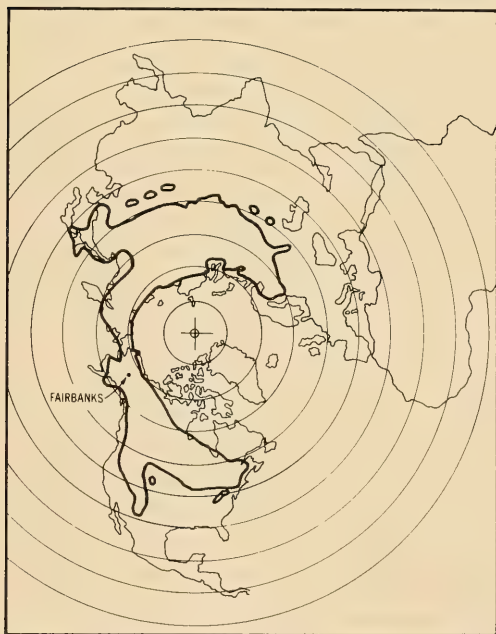


FIGURE 1. Distribution of *Rosa acicularis* Lindl. is outlined on the map. Seeds for this study were collected near Fairbanks, Alaska.

Materials and Methods

Hips¹ were collected in September 1972, May 1973, September 1974, and September 1975 near Fairbanks, Alaska (64°51' N, 147°44' W). Achenes were separated from the pulp, washed, dried at room temperature for 48 h, and stored at 2–3°C in plastic bags.

Laboratory germination experiments were conducted in controlled-temperature ($\pm 1^\circ\text{C}$) growth chambers with light/dark period of 16/8 h under white fluorescent tubes, light intensity 200 to 500 foot candles. Distilled water was used for all laboratory experiments. Seeds were germinated on vermiculite in plastic containers with transparent lids and three or four 50-seed replications were used for each treatment. In laboratory tests, emergence of the radicle was regarded as germination, but seedlings were transplanted to soil to check for normal development.

To determine the conditions necessary to break dormancy, the following laboratory experiments were conducted on seeds collected in September 1974.

(1) Seeds were cold stratified at 5°C for 1 year. Germination occurred at stratification temperatures.

(2) Seeds were soaked for 1 h in concentrated H_2SO_4 , rinsed, and stratified at 5°C. The acid treatment reduced the thickness of the pericarp by half. On a portion of the seeds the pericarp was entirely removed in spots, and in some seeds the testa was also removed in these spots. Germination occurred at stratification temperatures.

(3) Seeds were warm stratified at 25°C for 115 days on cellulose pads and then placed on moist vermiculite at 5°C. Two weeks after germination began at 5°C, sets of replications were moved to 20°C and 10°/20°C². One set of replications was retained at 5°C. In all experiments, seeds that had not germinated at the end

of the experiments were dissected to determine the number of filled seeds. Germination percentages are based on the number of filled seeds.

To examine the response of the seeds to outdoor conditions, and to test planting methods for artificial revegetation, the following experiments were conducted.

(1) Seeds collected in May 1973, from hips which had overwintered attached to the plant, were placed on soil in six pots, 25 seeds per pot, and covered with 2 cm humus and litter. Pots were placed outdoors in May. Seeds in the pots overwintered under the snow until 22 January. Then, because of time restrictions on the experiment they were dug out of the snow, brought indoors, and placed at 5°C to determine the response of the seed lot to the environmental conditions of the summer, fall, and one-half of the winter.

(2) An attempt was made to shorten the normal 2-year period between planting and germination. Seeds collected in early September 1974 were warm stratified for 1 month at 25°C and then planted outdoors on a mineral soil seedbed in early October.

(3) To determine if any seeds would germinate the first spring after they were produced, after being subjected to a fall and winter of cold stratification but no warm temperatures, seeds were collected in September and planted outdoors on a mineral seedbed.

Results and Discussions

Seeds which were cold stratified at 5°C (experiment 1) germinated slowly and incompletely (Figure 2). Germination began at 5°C after 110 days. Seeds retained at 5°C continued to germinate, and germination rate of these seeds increased after 220 days, but after 1 year only 57% of the seeds had germinated. The germination rate and capacity of seeds pretreated with acid (experiment 2) was very similar (Figure 2). The only effect of the acid treatment was that after 56 days, 4% of the seeds had germinated. These were seeds in which the acid had completely removed sections of the seed covers, including the testa.

Seeds which were warm stratified at 25°C for 118 days before being cold stratified (experiment 3) gave the most rapid and complete germination

¹The rose hip is an aggregate fruit enclosing several achenes. An achene is a one-sided fruit with the seed enclosed in a hard pericarp. This dispersal unit will hereafter be referred to as a seed.

²Diurnal alternation with a maximum of 20°C during the day for several hours, followed by a slow decline to a minimum of 10°C at night for several hours, after which temperatures slowly increased to 20°C.

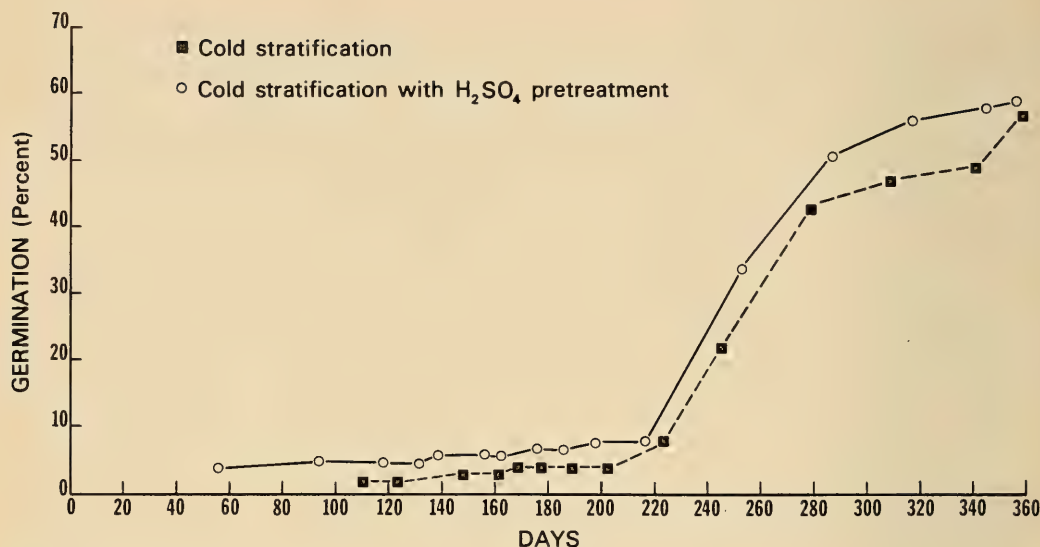


FIGURE 2. Effect of cold stratification at 5°C and cold stratification with concentrated H₂SO₄ pretreatment on germination of *Rosa acicularis*. Day zero is the day seeds were placed at 5°C, and germination occurred at stratification temperatures.

(Figure 3). Germination began after 92 days at 5°C. Germination had reached 60% at 5°C after 107 days, when sets of replications were moved to 20°C and 10°/20°C. There were no significant differences in total germination between these seeds and the set of replications kept at 5°C. Apparently in seeds which are pretreated with warm stratification, metabolic processes involved in breaking of dormancy under cold stratification proceed at a relatively similar rate in the entire seed lot. Seeds then germinate quickly over a wide range of temperatures.

Investigators (Blundell and Jackson 1971; Svejda 1968) working with other species of *Rosa* have reported that the role of acid or warm stratification pretreatments was to break down the pericarp, reducing mechanical resistance to embryo growth, or reducing the amount of inhibitors present in the pericarp. In *R. acicularis* the pericarp does not inhibit imbibition of moisture, and it apparently offers little resistance to embryo growth. After 2 or 3 months of cold or warm stratification, the seeds can be easily opened along the suture. In many seeds, the pericarp is split open and may fall off, but the seed remains dormant. The breakdown of the pericarp to reduce the amount of inhibitor present is probably not a major role of warm

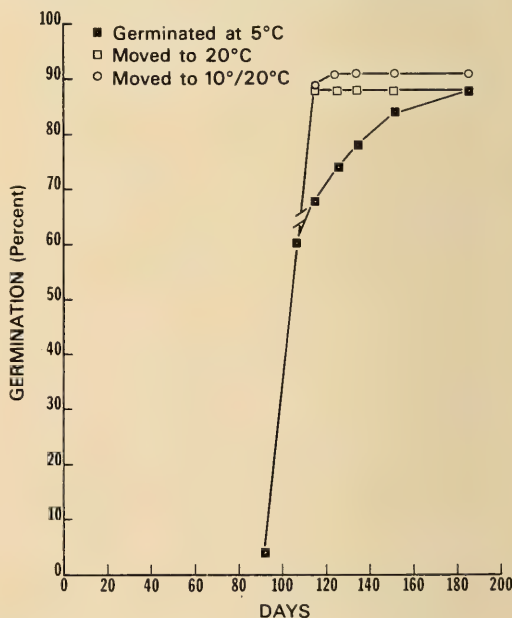


FIGURE 3. Effect of warm stratification at 25°C followed by cold stratification at 5°C on germination of *Rosa acicularis*. Day zero is the day seeds were transferred from 25°C to 5°C. Slash indicates that some replicates were moved to higher temperatures after 60% of the seed lot had already germinated.

stratification in *R. acicularis*, as the pericarp appears to play a lesser role relative to other seed parts in physiological dormancy. Seeds in which half or more of the pericarp had been removed by acid germinated more readily than intact seeds only when a portion of the testa was also removed.

Exploratory tests on the role of the pericarp and testa in imposing dormancy were conducted on samples of seeds from all experiments which remained dormant after 1 year of treatment. The pericarp or both the pericarp and the testa were removed, and the seeds were placed at 5°C for germination. Removal of the pericarp resulted in only 8% germination, whereas removal of both the pericarp and the testa gave 100% germination. These results suggest the importance of the testa in controlling dormancy. Embryo dormancy is indicated by the fact that over half of the seedlings germinated from naked embryos showed the abnormalities typical of extracted embryos from deep dormant seed (Nikolaeva 1969).

It is likely that the role of warm stratification in *R. acicularis* is that suggested by Nikolaeva (1969) and Villiers (1972). That is, in most deep dormant seeds the initial stages of germination (e.g., water uptake beginning of enzymatic activity and hydrolysis of reserve substances, and beginning of embryo growth) will occur at stratification temperatures. In some species, however, apparently including *R. acicularis*, warmer temperatures are required. Seeds must then be moved to cold stratification temperatures for germination processes to continue.

Seeds from fruits which overwintered on the plant and were planted outdoors did not germinate during the growing season. After overwintering under the snow until January, the seeds were brought indoors and placed at 5°C. Seedlings appeared above the soil after 22 days, and 18 more days were required to reach 50% germination. Germination rate to 50% germination was similar to those seeds which were pretreated with warm stratification and then cold stratified. The experiment was terminated 44 days after germination began, when 67% of the seeds had germinated.

Of the seeds artificially warm stratified and planted outdoors in the fall of 1974, 16% germinated in the spring of 1975 immediately

after snowmelt. The remainder germinated the following spring immediately after snowmelt.

Seeds planted in September 1975 did not germinate in the spring of 1976. Observation of these seeds will continue.

From the laboratory experiments and field observations, a description of the germination ecology of *R. acicularis* can be suggested. In interior Alaska, many seeds are freed from the fruit and dispersed prior to snowmelt by mammals and birds that eat the fruit and defecate the seeds. Very few or none of these seeds germinate in the spring. Some seeds overwinter in the fruit, often attached to the plant. These fruits are usually shed when the new leaves appear in late spring, and the fruits decompose rapidly. The seeds are subjected to summer temperatures for warm stratification, and cold stratification requirements are met during the fall and winter. Under environmental conditions in interior Alaska, most cold stratification of seeds probably takes place at or near 0°C. After stratification, seeds are capable of germination over a wide range of temperatures and germination occurs soon after snowmelt the following spring. The ability of *R. acicularis* to germinate with vigorous seedling growth at low temperatures enables the species to establish in a wide variety of habitats and to take advantage of good moisture conditions in early spring.

Rosa acicularis seedlings, once established, spread vegetatively by rhizomes over wide areas (Calmes and Zasada, unpublished data). Since resprouting occurs after fire and other disturbance destroys the above ground portion, clones could possibly persist for hundreds of years. *Rosa acicularis* produces a relatively small number of seeds, and natural selection seems to have favored adaptations which favor dispersal to safe sites and seedling establishment. Considerable energy is allocated to the edible hip to provide for animal dispersal, which increases the chances that seeds will be dispersed to suitable habitats. The complex dormancy mechanisms not only provide for germination and seedling establishment under suitable conditions, but may spread the germination of one seed crop over several years. The small number of seeds produced is compensated for by large seed size. The large seeds have enough stored food to produce rapidly a large root system and vigorous

seedling growth. This increases chances of seedling survival (Stebbins 1971), giving the seedlings a competitive advantage and allowing them to exploit fully the favorable conditions existing at the time of germination.

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Nesting Biology of the Sora at Vermilion, Alberta¹

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Abstract. Nesting habitat, clutch sizes, and hatching success for 50 Sora nests in the Vermilion area of eastern Alberta are described for 1957 and 1958, two dry years on the prairies. *Carex* spp. alone or in association with other emergent aquatic plants were the preferred nesting cover in both years, although more plant species were involved in 1958, the drier year. The mean clutch was 12.2 eggs, but hatching success declined from 80.6% in 1957 to 59.6% in 1958. Trampling by cattle and increased predation accounted for the doubled egg loss in 1958 and were attributed to increased exposure of the nests through rapidly declining water levels that year. The existence of late nests suggested second attempts, but the only second nest recorded involved at least one member of a pair which had successfully hatched the first clutch. The data presented, for the nesting period only, suggest that the Sora is a successful breeding bird in this area of its range, that its high egg productivity is not affected by lower water, but that naturally declining water levels do increase egg mortality.

Although considered a game bird, the Sora (*Porzana carolina* L.) has been little publicized in the ornithological literature. Bent (1926) summarized works on the Sora up to that date. Allen (1934), Mousley (1937), Nichol (1938), Walkinshaw (1935, 1940), Billard (1948), and Pospichal and Marshall (1954) have since reported on various aspects of its breeding biology. They all worked in areas where other rallids, mainly the Virginia Rail (*Rallus limicola* L.), coexisted with the Sora, and frequently drew comparisons between Sora and Virginia Rails. The present study, carried out in 1957 and 1958 around Vermilion, Alberta reports on nesting habitat, clutch sizes, and some factors influencing hatching success of eggs of Soras in that region. Soras were the only rails known in the area until at least two pairs of Virginia Rails appeared just outside the study area in 1958 (Lowther 1961); thus the data reported are for the Sora in absence of competition with other rails.

The Study Area

The study area was in the aspen parkland region of Alberta, and consisted of strips of land 90.1 km long and 0.20 km wide on each side of Highway 41. Extremities of this area are approximately 41.2 km south of, and 53.1 km north of, Vermilion (53°00' N, 110°50' W to 53°50' N,

110°50' W). Most of the present data on Soras were collected on the western half of this area, in connection with waterfowl studies by the Canadian Wildlife Service.

The years in which this study was conducted lie within a period of increasing drought on the Central Plains. The water table in 1958 was lower throughout the season than in 1957. In mid-May of the first year, there were 273 wet ponds in the 19 km² of the waterfowl study area, whereas the 1958 season started with only 240 wet areas. As the 1958 season progressed, more water was lost through evaporation than during the previous year.

Methods

Sora nests were found fortuitously during the waterfowl studies, mainly by the two dogs used. No systematic nest-searching was done.

When a nest was found, the date, number of eggs, stages of incubation, nesting cover, and nest materials were recorded. Subsequent visits provided data on nesting success and incubation periods.

The average incubation period of 18.7 days recorded by Pospichal and Marshall (1954) and the "correct period" of 19 days recorded by Nice (1954) were accepted. From this, the stages of the 23-day incubation period of pheasant eggs determined by floatation in water (Westerkov 1950) were pro-rated to a 19-day period. In 1958, Sora eggs were floated in water to determine the stages of incubation, and from this an expected hatching date was calculated and verified upon

¹This paper is based on a report, submitted in 1958 to the Canadian Wildlife Service, covering part of the work done while the author was in the temporary employ of this Service.

subsequent visits to the nests. As incubation begins before the clutch is completed and hatching takes place over several days, it was necessary to number and float each egg and group them according to the stages of incubation found. In nests revisited prior to hatching, one egg from each group was refloated and the expected hatching date was recalculated. Whenever possible, the nest was revisited to verify that date.

In 1957, attempts were made to capture, band, and color-mark Soras, particularly incubating adults. Red or yellow airplane dope was used on the wings and red dope on the aluminum leg bands. The few subsequent observations showed that the color did not last long enough to provide substantial data, particularly considering the effort spent in the capture of the birds. The red dope on the bands and the yellow on the feathers were the best, and were visible within 15 m. The red bands, while the color lasted, gave good contrast with the colors of the leg and vegetation.

Methods of capture were by Japanese mist nets, drop-traps over nests, hand nets, drive traps, and dogs. In 1957, 14 adults, 19 flightless young, and 5 flying immatures were caught—a total of 38 birds. In 1958, no effort at banding was made.

Whenever possible in the analysis of data, the validity of comparisons was determined using the *chi*-square test.

Results and Discussion

Nests, Clutch Size, and Incubation Period

During the two years, 50 Sora nests were found, 24 in 1957 and 26 in 1958. The first nests were found 23 May 1957 and 24 May 1958. Clutches were complete in both cases. The last complete clutch of 1957 was found 2 July, after which four incomplete but hatching clutches were located up to 20 July. The latest date on which a complete clutch was recorded in 1958 was 17 July, and no nests were found after that.

Although some late nests found each year may have been second attempts, only one known second nesting was recorded. The first nest found in 1957, on 23 May, contained 12 eggs, all of which had hatched by 6 June. The adults were caught, banded, color-marked, and from subsequent sightings were the only pair on the

500-m² pothole. On 12 June, four fresh eggs were found in the same nest, with one of the marked adults in attendance. Also seen was another adult with two downy young, but its identity was not determined. Assuming one egg was laid per day, the interval between the hatching of the first clutch and initiation of the second was only 2 days. This is shorter than the 12-day inter-nest period reported by Pospichal and Marshall (1954). Further, it was the second effort following an apparently successful first one.

In 1957, the mean size of 14 complete clutches was 12.0 eggs (range 9 to 16), compared with a mean of 12.3 eggs (range 9 to 14) for 18 clutches in 1958. As there is no significant difference between the two means, the overall mean clutch size was 12.2 eggs. This figure approximates those published by others.

The literature reveals wide discrepancies in the reported incubation period of Sora eggs. Bent (1926) states 14 days, Walkinshaw (1935, 1940) 16 to 21 and 15 to 19 days respectively, Pospichal and Marshall (1954) 11 to 22 days with an average of 18.7, and Nice (1954) gives a "correct period" of 19 days. With the assumption of the 19-day period of the last two studies, coupled with a modification of Westerkov's (1950) floatation method to determine the stages of incubation (see Methods above), the hatching dates calculated and verified for eggs in 1958 confirm strongly an incubation period of 19 days.

Nesting Cover and Nest Materials

The dominant nesting cover used by Soras in both years was *Carex* spp., mainly *C. atherodes*, either alone or in association with other emergent plants (Table 1). Although the incidence of *Carex* around the nest sites was the same in both years, there were significant differences between the years in the dispersion of *Carex* and other plants. Nests in pure *Carex* tussocks were found at 18 of the 23 sites (78.3%) (not counting the second nesting) in 1957 compared with only 10 of the 26 nests (38.5%) in 1958. Conversely, in 1958 there were relatively more nests in mixed associations of *Carex* and other plant species and in plants not associated with *Carex*, than in 1957. These included willows (*Salix* spp.), mixed grasses, *Glyceria grandis*, *Alisma plantago-*

TABLE 1—Numbers of nests of Soras found in different types of nesting cover in 1957 and 1958 near Vermilion, Alberta

Vegetation	1957	1958
<i>Carex</i> spp.	18 ^a	10
<i>Carex</i> and <i>Alisma</i>	1	—
<i>Carex</i> and <i>Eleocharis</i>	—	1
<i>Carex</i> and grasses	1	1
<i>Carex</i> and <i>Juncus</i>	—	1
<i>Carex</i> and <i>Sagittaria</i>	—	1
<i>Carex</i> and <i>Salix</i>	1	4
<i>Eleocharis</i> sp.	1	2
<i>Glyceria grandis</i>	1	1
<i>Juncus</i> sp.	—	1
<i>Polygonum coccineum</i>	—	1
<i>Typha</i> sp.	—	3
Totals	23	26

^aSecond clutch in first nest not included.

aquatica, *Eleocharis* sp., *Juncus* sp., *Polygonum coccineum*, *Sagittaria* sp., and *Typha* sp.

The greater diversity of plants used as nesting cover in 1958 could reflect the relatively lower water levels throughout that year. The inner, more mixed rings of vegetation were more readily available to the birds than were the outer areas of *Carex*. This change is related to the deviant vegetation patterns of marshland, related to drought, described by Millar (1976). Water-depth requirements for nesting reported by Bent (1926), Mousley (1937), Walkinshaw (1940), and Pospichal and Marshall (1954) were between 15 and 30 cm. This requirement was met in the *Carex* stands of 1957, but with the reduced water levels of 1958, *Carex* was found in little or no water, thus was unacceptable. Only the inner, sparser, more mixed stands of vegetation grew in the required depth of water. Although exact water levels were not recorded during this study, it seems reasonable to accept water depth as a major stimulus to nest-site selection, and the lower water in 1958 as the factor responsible for the greater diversity of nesting cover used that year. At the same time, it appears that the presence of *Carex* is a preferred feature of the nest site, but that other plant species may be used secondarily when water depths around *Carex* are too shallow.

Typha is the nesting cover most frequently reported for the Sora in the eastern portion of its

range. This plant was rare in the Vermilion area, and exploration of the few *Typha* stands revealed Soras in densities no greater than found elsewhere in the region. This further supports the idea that Soras are adaptable to the marsh vegetation in an area, as well as under different conditions, other habitat features being similar.

Materials used in nest construction reflected the vegetation about the site selected. In 1957, *Carex* was found in all 23 nests (17 of *Carex* alone, 5 mixed with aspen leaves, and 1 with *Eleocharis*). The nests in 1958 were of more diverse structural materials. Sixteen nests were made solely of *Carex*, three of *Typha*, one of grasses and *Eleocharis*, and the remainder of *Carex* with other vegetation: two with aspen leaves, two with grasses, one with willow leaves, and one with *Eleocharis*. As with nesting cover, the greater diversity of nest materials is probably a reflection of the lower water and the differences in nesting cover available in that year.

Hatching Success

As hatching in each nest occurs over a period of a few days and as loss of nests sometimes occurred during the hatching period, the breeding success was measured in terms of the fate of each egg rather than for the individual clutch (Table 2).

Hatching success was significantly lower in 1958 (59.6%) than in 1957 (80.6%). Conversely, egg loss was significantly higher in 1958 (40.4%) than in 1957, when only 19.4% of the eggs were lost or not accountable. Loss through predation was greater in 1958, when five nests, collectively containing 58 eggs, were later found to have had the eggs punctured but not crushed: these were designated as avian predation. In 1957, the only eggs believed taken by birds were the four deserted in the second nesting. Grackles (*Quiscalus quiscula*) were common in the area and might have been involved in the 1958 nests, and they or crows (*Corvus brachyrhynchos*) may have taken the 1957 nest.

Mammalian predation was believed to have occurred both years. A coyote was held responsible for the destruction of one nest and an adult in 1957. In 1958, one complete and one incomplete clutch were lost to mammals. Tracks of a skunk were found around the latter. At the complete nest, some of the eggs were crushed,

TABLE 2—Fates of Sora eggs found in 50 nests in 1957 and 1958 near Vermilion, Alberta. Data are tabulated separately for each of the two years and for the two years combined. The figures in parentheses represent the percentages of the total for that column

Fate	Number of eggs (% of total)		
	1957	1958	Both years
Hatched	174 (80.6)	153 (59.6)	327 (69.1)
Predated			
Avian	—	58 (22.5)	58 (12.2)
Mammalian	6 (2.8)	17 (6.6)	23 (4.9)
Total	(6 (2.8))	(75 (2.91))	(81 (17.1))
Trampled	—	27 (10.5)	27 (5.7)
Deserted	4 (1.8)	—	4 (0.9)
Embryonic death	—	2 (0.8)	2 (0.4)
Infertile	—	—	—
Unknown	32 (14.8)	—	32 (6.8)
Totals	216	257	473

the others missing, and the nest torn apart. In all three cases, there was little or no water about the site.

In 1958, two additional nests were lost through trampling by cattle. These nests were built in *Eleocharis* and *Juncus* respectively. There was no water under either nest.

The greater egg loss in 1958 may be attributable to the diminishing water that year, resulting in nests being built in vegetation thinner and sparser than *Carex*. The nests themselves and the activities of the adults about them would have been more readily visible to predators. Also, the more concentrated movements of cattle around diminishing water supplies would have increased the chances of trampling.

There was no evidence of infertility in any of the successful nests. Two of the 329 eggs in such nests, however, showed embryonic death, both eggs being addled and containing partially developed embryos.

The data presented above indicate that, in the Vermilion area where other rallids were absent, the Sora is a prolific egg layer, and that it is adaptable to various types of vegetation for nesting cover under conditions of diminishing water levels. The shift in nesting cover from *Carex* to sparser sedges, grasses, and other plant species resulted in higher egg loss through predation and trampling by cattle. Despite this, casual observations of young in the region both years suggest good post-nesting survival to the

flying stage.

The adaptability of the Sora to various types of aquatic vegetation for nesting is probably basic to its wide distribution in North America. As mentioned above, *Typha* is the preferred nesting cover in the east, *Scholochloa* in the Delta Marshes of Manitoba (personal observations), and from this study, *Carex* in central Alberta. *Scirpus* is most often used by Soras in interior British Columbia (A. J. Erskine, personal communication). Shifts in habitats utilized under drought conditions argues further for versatility. This leads one to speculate on competitive interaction between the ubiquitous Sora and other, co-existent rallids less broad in distribution. More detailed studies of the Sora by itself, compared with those of the same species co-existing with other rails, could provide a better definition of the primary habitat requirements of the Sora and of the other species during the breeding season.

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Notes

Predation by Wolves on Wolverines

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During a study involving the collection or recording of 74 wolverine (*Gulo gulo*) carcasses from trappers in the northern Mackenzie District of the Northwest Territories, two instances of wolves (*Canis lupus*) killing wolverines were recorded. Age class determinations for the wolverines were based on cementum annulation counts and air-dried baculum weights (Rausch and Pearson 1972). Kidney-fat indices (KFI) were established using Riney's (1955) methodology.

G. Niditchie of Arctic Red River, Northwest Territories turned in the carcass of a female wolverine (age class 2) that he had observed being killed by a lone wolf on 19 January 1974, on Neando Lake (66°47' N, 133°10' W). The wolverine had been caught by the forepaw in a steel trap and had dragged the trap and toggle onto the lake ice. When the trapper approached from the far end of the lake, he observed a lone wolf attacking the wolverine. By the time the trapper arrived at the scene, the wolverine was dead and the wolf departed, presumably as a result of the arrival of the trapper and his dog team.

When I examined the skinned carcass of this wolverine, I found a 5-cm tear and two tooth punctures in the dorso-posterior of the right temporal muscle. The pleural and cardiac cavities had been torn open and the heart removed. No other marks were on the carcass except for trap and skinning marks. The animal had a KFI of 30.4% which indicated its comparatively good condition. In this study, the mean KFI of winter-caught males ($n = 20$) was 17.8%; and the mean KFI of winter-caught females ($n = 19$) was 18.5%. Rausch and Pearson (1972) found higher mean KFIs for Alaskan wolverines.

The second case of predation was reported by C. Andre of Arctic Red River, Northwest Territories. On 20 November 1974, he observed the fresh tracks of one wolverine and an estimated four wolves leading north away from his snowmobile trail. The trail was located on an old seismic exploration line which had been cut through the lichen-stag spruce (*Picea mariana*) forest. The tracks indicated that the wolves and wolverine had both come from the east along the trail. Andre had come from the southwest. A few hundred metres away from the snowmobile trail, he found the unfrozen carcass of a male wolverine (age

class 14–15) amid broken bushes and disturbed snow. The kill had taken place in a large treeless area (67°27' N, 132°00' W), containing scattered shrubs less than 1.5 m in height.

I found this wolverine had a large tear in the claviobrachialis and clavotrapezius muscles. The abdomen had been torn open, but the viscera were intact. The stomach contained ptarmigan (*Lagopus* sp.). A KFI of 20.8% showed the animal to be in good condition in comparison with other specimens.

Burkholder (1961) reported an instance of predation by wolves upon a wolverine. Freuchen (1935) was told by an Inuit of a wolf-wolverine encounter in which the wolverine was killed and the wolf injured. Murie (1963) observed three unsuccessful attacks by wolves on wolverines in Alaska. In each case, the wolverines escaped by climbing trees. Flook and Rimmer (1965) documented a case of cannibalism involving wolverines, but under unusual circumstances. Banfield (1974) reported porcupine (*Erethizon dorsatum*) quills to be the cause of death of one wolverine. We found porcupine quills in only one of 54 carcasses collected, and they did not appear to be causing serious trauma.

Stenlund (1955), Mech (1966, 1970), and Banfield (1974) report wolves killing colored foxes (*Vulpes vulpes*) and coyotes (*Canis latrans*); both, along with wolverines, are potential competitors with wolves for prey and carrion. Young and Goldman (1944) referred to the killing of a black bear (*Ursus americanus*) and arctic foxes (*Alopex lagopus*) by wolves, but the reports are unsubstantiated. Marhenke (1971) recorded the killing of a lone wolf by four other wolves. The degree of predatory pressure exerted by wolves on other carnivores is subject to debate (Mech 1966, 1970; Murie 1944; Goldman and Young 1944).

In the incident described by Burkholder (1961) and both of those reported here, the wolverines killed were unable to escape to trees. In one case, the toggle prevented the animal from reaching and climbing nearby trees; and in the other two cases, no large trees were present. Freuchen's (1935) report was probably also from a treeless area. As wolverines are quite at home in trees (Krott 1958) and can escape wolf attacks by climbing trees (Murie 1963), their predation by

wolves is probably less frequent in areas where large trees are present.

The wolf-killed wolverine reported by Burkholder (1961) was not eaten, nor were those reported here except for the heart in one case. The reason may be related to palatability and hunger level. In two cases described by Mech (1966) in which wolves killed colored foxes, one was left intact and the other was disembowelled but not eaten. I have noted that many sled dogs will not eat the meat of wolverines, marten (*Martes americana*), mink (*Mustela vison*), and colored foxes unless they are very hungry. Wolves do frequently rob trappers' sets of animals such as martens for food, and sometimes eat other wolves.

The reason why wolves sometimes kill wolverines and other carnivores can only be guessed but may involve factors of interspecific competition and territoriality, hunger, or curiosity. The reason and role of predators killing other predators is an area of study that has not been clarified in the literature and deserves more attention.

The skulls of the specimens have been deposited in the National Museum of Natural Sciences, Ottawa, Canada, catalogue numbers 42855 and 42856.

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Chipping Sparrow Hanged

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From 5 to 10 June 1975 a pair of Chipping Sparrows (*Spizella passerina*) was observed building a nest in the top of a 4.6-m (15-ft) balsam fir (*Abies balsamea*). The tree is less than 1.8 m (2 yards) away from a house on the campus of Macdonald College, Ste. Anne de Bellevue, Quebec.

On 10 June, one of the pair was seen dangling in the tree, directly under the partially built nest. Closer investigation revealed that the bird had been strangled

by two human hairs, blond and about 20 cm (8 in) long. It appears that in attempting to incorporate the hairs into the nest, the bird's head became entangled in the hairs, which were fastened to a twig. Unable to extricate itself, the sparrow strangled. The other member of the pair was never seen again.

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Sources of Mortality in Concentrated Garter Snake Populations

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Any concentrated population of animals is unusually vulnerable to predation and other sources of mortality. As a rule, reptiles are solitary in habit. In northern portions of its range, the red-sided garter snake (*Thamnophis sirtalis parietalis*) is solitary in June, July, and August, but migrates to specific sites (limestone sinks) in September and remains densely aggregated until the end of May in the following year (Aleksiuk and Stewart 1971; Gregory 1973, 1974). Thus, for 9 months of each year, the entire population is densely aggregated at specific sites. There may be as many as 8000 to 10 000 individuals in limestone sinks measuring only 20 × 20 m (Aleksiuk 1976). Although the annual aggregating behavior appears to be important in over-winter survival (Aleksiuk 1976) and reproduction (Aleksiuk and Gregory 1974), it makes the population unusually vulnerable to mortality. Gregory (1977) noted instances of mortality in this population. The purpose of this note is to record major sources of mortality during the aggregated portion of the red-sided garter snake's seasonal life history.

The life history of the population under study has been outlined by Aleksiuk and Stewart (1971) and Gregory (1973). Notes of a qualitative nature were kept on sources of mortality at six large limestone sinks 80 km NNW of Winnipeg, Manitoba during the years 1969 to 1975, inclusive. Approximately 10 000 garter snakes were estimated to use each of three limestone sinks as hibernacula, and the remaining three sinks were used by lesser numbers of snakes (perhaps 3000–4000 in each case).

The most conspicuous source of mortality is the common crow (*Corvus brachyrhynchos*). The study area harbors a dense breeding population of crows. In April and May the limestone sinks usually have crows loitering in the area, and the sinks are strewn with partially-eaten snakes, many of which are still alive. These crow kills are very distinctive (Figure 1). In most cases, only the skin in the area of the liver is broken, and only the liver is removed. No other portions of the body appear to be eaten. A second source of mortality was observed when two limestone sinks were being excavated in the spring of 1973 (Hawley and Aleksiuk 1975). Several of the snakes collected by excavation of the sinks had portions of their heads freshly removed but were still alive. The appearance of the wound suggested that rodents had



FIGURE 1. A male red-sided garter snake that had its liver removed by a crow in May, shortly after the snake emerged from hibernation.

nibbled on the heads of the snakes as the torpid snakes worked their way through the rubble to the surface of the sink. No other portion of the body was touched by the predators. In one case, one of these snakes was observed on the surface, being courted by a male (Figure 2). Ground squirrels (*Spermophilus* spp.) made extensive use of one sink, and mice (*Microtus* sp.) were observed in other pits. These are the most likely agents of the observed predations. A third source of mortality was observed during the excavation. Several hundred dead snakes were found about 30 cm below the surface. The snakes had no wounds, and apparently had been frozen during the previous winter.

In late April 1973, hundreds of dead and mangled snakes were found in a large limestone sink. A burrow



FIGURE 2. A female red-sided garter snake that had the anterior portion of its head removed, apparently by a rodent. Photographed in May shortly after emergence from hibernation.

on one side of the sink and evidence of digging at the bottom of the sink indicated the presence of a mammalian predator. An "instant kill" conibear trap set in the burrow yielded a large adult striped skunk (*Mephitis mephitis*). The skunk had taken up residence next to a readily-available food supply. If I had not removed it, the skunk could easily have killed most of the snakes in that sink during the ensuing month.

The winter of 1973-74 had an unusually large amount of snow, and the spring of 1974 had heavy rains. The spring run-off caused serious flooding in many parts of the study area. Two major limestone sinks, each used by about 10 000 snakes, were completely covered by water from mid-April to late May. Because no snakes were observed to emerge from either sink in the spring of 1974, it was apparent that all individuals using those sinks had drowned. This was confirmed when it was observed that no snakes used the sinks during the winter of 1974-75.

In a discussion of animals that prey on reptiles, Porter (1972) states "Without doubt, man is a most important predator. . . ." In the case of *Thamnophis sirtalis parietalis*, man is the most important predator. Red-sided garter snakes have been collected commercially on the study area since 1955. Originally, the collections were small, but recently they rapidly increased in magnitude until 63 429 individuals were collected in 1974 in an area measuring about 50 × 50 km (Carol Scott, personal communication). The snakes were sent to the United States where they are sold as pets. A smaller but nevertheless significant human predation occurred in the village of Inwood.

Until 1974, a creamery was used as a hibernaculum by about 5000 snakes. In 1974, measures were taken to prevent this use, and as a result a large segment of the breeding population in that area was destroyed.

Therefore, although the annual aggregating behavior of the red-sided garter snake in the northern portion of its distribution facilitates over-winter survival (Aleksiuk 1976) and reproduction (Aleksiuk and Gregory 1974), it also results in a large amount of mortality. A fine balance undoubtedly exists between the advantages (survival and reproduction) and disadvantages (mortality) of this aspect of the population's life history, with the balance normally tilting slightly in favor of survival and reproduction. Currently, the balance appears to have tilted strongly in favor of mortality (three of six dense aggregations destroyed, and the other three greatly reduced).

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Micro-habitat Selection of Chestnut-cheeked Voles (*Microtus xanthognathus*)

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Because of the remoteness of the areas in which they occur and because of their relative scarceness, little is known about chestnut-cheeked voles, *Microtus xanthognathus*. To obtain information on their micro-habitat preferences we visited a small unnamed lake where the voles appeared to be abundant. P. M. Youngman (1975. Mammals of the Yukon Territory. National Museum of Natural Sciences Publications in Zoology, Number 10. pp. 98-101) summarized the habitats in which chestnut-cheeked voles occurred but did not present data on micro-habitat selection. This paper presents information concerning micro-habitat selection within a riparian habitat.

Three days of micro-habitat analysis during August 1973 and one day during July 1974 were expended at a small lake where many chestnut-cheeked voles had been observed. The lake (65°54' N, 127°59' W) is located 80 km northwest of Norman Wells, Northwest Territories. An effort was made to identify the types of vegetation and topography in which various kinds of vole activity occurred.

Sampling was conducted in the margin between the edge of the water and the edge of the forest. This margin was an average of 25 m wide (range 21 m to 28 m) and consisted of a gently sloping beach covered with sedge (*Carex* spp.) and litter extending 15 m from the edge of the water to the base of a relatively steep bank. Black spruce (*Picea mariana*) and white spruce (*P. glauca*) covered the top of the bank.

Indirect evidence of vole activity and vegetation preferences was gathered on the edge of the lake. Seven sampling sites were located randomly around

the lake. At each a set of five 10-m-long line-transects was established. The five transects were placed parallel to each other at 5-m intervals. The first transect at each site was placed at the water's edge, with the remaining four located in the middle of the beach, the base of the bank, the middle of the bank, and the top of the bank. The numbers of runs, burrows, and cuttings were recorded along 1-m sections at 1-m intervals along each transect line. Runs, burrows, and cuttings left by chestnut-cheeked voles are considerably larger than those left by smaller voles and are therefore easily distinguishable. We felt that no sign left by other voles was included in our observations. Percentage coverage of grass and sedge, forb, shrub, litter, and exposed soil was estimated at the same sampling intervals as the sign counts. All transects were examined during 1973 and 1974.

The results of the habitat and sign analyses are presented in Figure 1. A total of 414 observations of sign was made during August 1973 and only 215 during July 1974. Fewer observations of sign may have represented a lower population of chestnut-cheeked voles or a lack of accumulation of sign due to sampling earlier in the season during 1974 than 1973.

The cuttings were mostly graminoids and were comprised of 89% *Carex* spp., 5% *Rumex arcticus*, 3% *Calamagrostis canadensis*, 2% *Vaccinium vitis-idaea*, and 1% *Equisetum* spp. Most of the sign occurred on the beach where grass and sedge cover was highest (Figure 1). Few cuttings were found on the bank where grass and sedge were almost absent. Litter was denser on the beach and probably provided protective

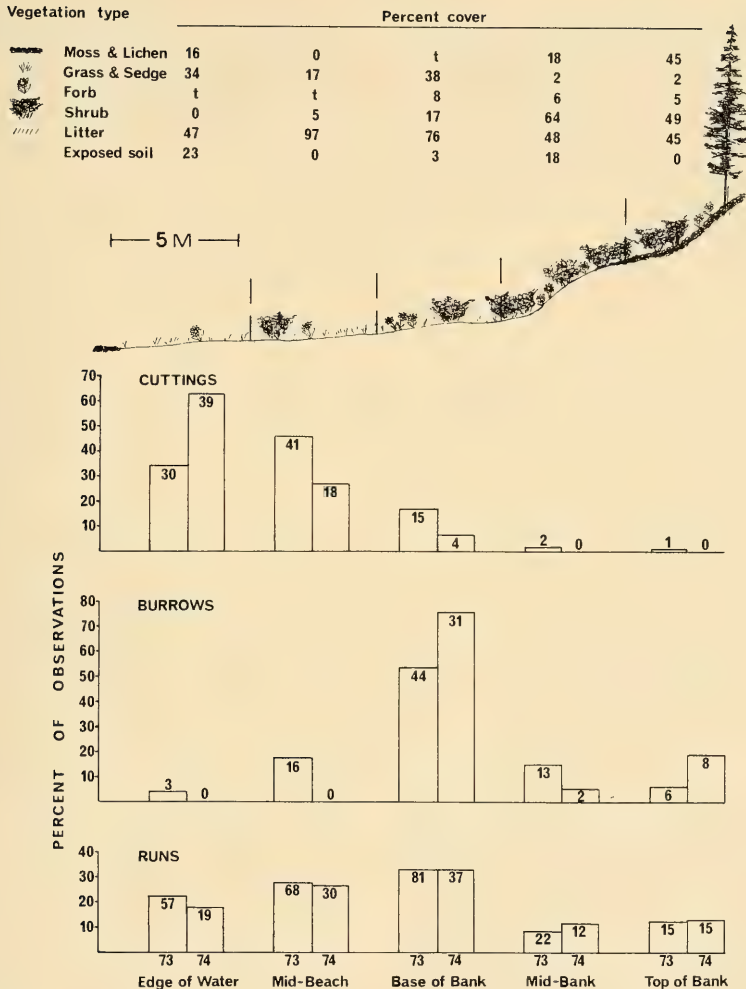


FIGURE 1. Distribution of chestnut-cheeked vole "sign" during 1973 and 1974 in relation to vegetation and microtopography on the margin of a small lake located in the Northwest Territories. The 't' represents cover values less than 1%. Numbers in the bars represent the number of observations. The diagram is schematic, drawn to approximate scale, and represents only an average cross section of the beach.

cover during cutting activities.

Most burrows were concentrated along the base of the bank (Figure 1). Few burrows were found higher up the bank and even fewer on the beach. The base of the bank had a dense cover of graminoids and litter, and was at a point where both the water table and active layer (that layer of soil that thaws during the summer but is underlain by permafrost) were deep enough to allow burrowing. Thus the burrows were

located as close to food and cover as burrowing conditions would allow. Even though graminoids were densest near the burrows, most cuttings were found closer to the water. Either the voles did less foraging near their burrows or they removed the cuttings close to the burrows more often than the distant cuttings.

Of the three types of sign, runs were the most evenly distributed in relation to the beach and bank but, like

cuttings and burrows, most were observed between the lake and the base of the bank (Figure 1). Runs along the lake edge often went through puddles of water, as noted by C. J. Lensink (1954). Occurrence of *Microtus xanthognathus* in Alaska. *Journal of Mammalogy* 35(2): 259–269) but as observed by Youngman (*op. cit.*), most were located away from the water. Runs located on top of the bank did not lead into the forest but other runs were observed in the forest away from the bank.

Chestnut-checked voles were found in other habi-

tats near the lake, especially in the black spruce forest, but their micro-habitat preferences were not as obvious as these.

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Variation in Selected Meristic Series in the Golden Shiner, *Notemigonus crysoleucas* (Mitchill), in the New Brunswick – Nova Scotia Border Region

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Abstract. Population of *Notemigonus crysoleucas* inhabiting five lakes of varying limnological characteristics near the New Brunswick – Nova Scotia border did not show differences in the number of dorsal or pelvic fin rays or in the number of scale rows above the lateral line. One lake in the series, Layton's Lake, supported a population with a significantly lower number of lateral line scales. Population differences in number of anal fin rays could not be related to temperature differences or to differences in other limnological variables and are postulated to result from genetic differences among the populations.

The golden shiner, *Notemigonus crysoleucas* (Mitchill), is a common cyprinid in eastern North America with a range which extends from Florida north to central New Brunswick and west into the Dakotas and Manitoba (Scott and Crossman 1973). Hubbs (1921) discussed the variability that exists in the number of anal fin rays of this species over its range and Schultz (1926) established that the variation was clinal with a northward decrease in the number of anal fin rays that correlated well with average May isotherms. Hubbs (1926) accepted this northward decrease in anal fin ray number as one of the valid exceptions to the normal pattern displayed by fish in which the number of meristic units increase with decreased environmental temperature.

Notemigonus crysoleucas is the most abundant cyprinid in the lakes of the New Brunswick – Nova Scotia border region. The correlation between the anal ray number and environmental temperature established by Schultz (1926) predicts an average anal ray number in this region of approximately 13.2, which agrees well with the average values given by Scott and Crossman (1973) for small samples of 10 fish from both Nova Scotia (\bar{x} = 13.3) and New Brunswick (\bar{x} = 12.8). Some environmental factors

other than temperature, however, such as salinity (Lee and Williams 1970), parasitic infection (Hubbs 1941), and photoperiod (Lindsey 1958), can alter meristic and morphometric characteristics of fish. In addition, meristic variability among populations can be genetic through the operation of complex multi-factor systems (Barlow 1961) or the product of minor environmental changes during critical periods of development (Taning 1952). The occurrence of populations of *N. crysoleucas* in lakes of varying limnological characteristics but located in a small geographical area and displaying very similar temperature regimes offers an opportunity to examine the possible roles of the combined effect of these limnological variables in modifying certain meristics of the species.

Methods

Fish were collected in September, October, and November by seining and gill-netting and preserved in 10% formalin. The lakes sampled and certain of their limnological characteristics are given in Table 1.

Meristic counts were taken under 10× or 20× magnification. Dorsal and anal fin ray counts included the long unbranched ray that reaches to near the tip of the fin, but the last branched ray elements

TABLE 1—Limnological characteristics of the five lakes sampled in the New Brunswick–Nova Scotia border region

Locality	Location	Classification	Area (ha)	Maximum depth (m)	Average pH*	Average conductivity* ($\mu\text{mhos cm}^{-1}$ at 25°C)
Morice Lake	45°56' N, 64°21' W	polymictic mesotrophic	140.4	3.2	6.7	58.9
Long Lake	45°57' N, 64°14' W	polymictic mesotrophic	65.7	2.0	6.8	44.0
Large Lake	45°57' N, 64°15' W	polymictic mesotrophic	135.0	1.5	7.1	80.6
Wood's Pond	45°53' N, 64°24' W	polymictic dystrophic	0.99	2.0	4.5	38.6
Layton's Lake	45°47' N, 64°15' W	meromictic eutrophic**	11.3	11.0	7.5	525

*Based on average for ice-free period.

**Mixolimnion thermally stratified in summer.

were counted as one, even though these elements are often separated to the base of the fin. Counts of lateral line scales included all pored scales. The number of scale rows above the lateral line was determined by counting downwards and backwards along the scale row, starting immediately in front of the origin of the dorsal fin.

Representative samples of fish from all lakes, with the exception of Wood's Pond, were measured for standard length and the age of each individual was determined by counting scale annuli. These data were used to determine the approximate age and size relationship for the younger age classes of each population so that younger fish could be reasonably accurately placed, on the basis of size, into a particular year class. As 0+ and 1+ fish were most common in the samples from the four lakes, these age classes were used for the determination of possible year-to-year variation in the number of anal fin rays.

Each meristic series was analyzed by means of a

one-way analysis of variance. If this analysis revealed significant differences among the populations, all possible population pairs were tested using an unpaired *t* test.

Results

Significant differences do not occur among the five populations in the number of dorsal or pelvic fin rays or the number of scale rows above the lateral line. Fish usually had eight (71), or rarely nine (1), dorsal rays although Scott and Crossman (1973) give a distribution for other Canadian specimens of seven (2), eight (48), nine (1). These authors also give a distribution of pelvic fin rays of eight (2) or nine (34); all 72 fish examined in this study possessed nine rays. Specimens from the five populations had an average count of 9.9 rows of scales above the lateral line (9 (6), 10 (52), 11 (2)).

A comparison of the number of lateral line scales occurring in the five populations is given in Table 2.

TABLE 2—Variability in the number of lateral line scales in five populations of *Notemigonus crysoleucas* in the Nova Scotia – New Brunswick border region

Locality	Number of scales								N	Mean	SE
	42	43	44	45	46	47	48	49			
Morice Lake	—	—	—	1	8	0	5	3	17	47.06	0.33
Long Lake	1	1	1	1	7	7	3	8	29	46.93	0.34
Large Lake	—	—	—	—	2	11	1	1	15	47.07	0.18
Wood's Pond	—	—	—	2	9	6	3	1	21	46.63	0.22
Layton's Lake	—	2	5	6	5	5	1	1	25	45.52	0.25

TABLE 3—Variability in the number of anal fin rays in five populations of *Notemigonus crysoleucas* in the Nova Scotia - New Brunswick border region

Locality	Number of anal rays					N	Mean	SE
	11	12	13	14	15			
Morice Lake	—	18	42	15	—	75	12.96	0.08
Long Lake	—	13	36	21	2	72	13.17	0.09
Large Lake	—	4	22	14	—	40	13.25	0.10
Wood's Pond	1	9	12	2	—	24	12.63	0.15
Layton's Lake	6	44	41	2	—	93	12.42	0.07

Analysis of variance revealed a significant difference ($F = 4.78$; $df = 4, 102$; $P < 0.005$). Further comparison of population pairs showed that the Layton's Lake population had significantly fewer ($P < 0.005$) lateral line scales than the other four populations which did not differ in this meristic series.

Comparison, by means of unpaired t -tests, of the average number of anal fin rays in the 0+ and 1+ fish of each of the four populations revealed no significant differences ($P > 0.05$). Certain significant differences ($F = 17.78$; $df = 4, 299$; $P < 0.001$) do occur among the populations in the pooled average number of anal fin rays with a low value of 12.42 for fish from Layton's Lake and a high value of 14.25 for specimens from Large Lake (Table 3). The populations of *N. crysoleucas* from Layton's Lake and Wood's Pond are not significantly different ($t = 1.33$; $P < 0.10$) in anal fin ray number, but each had a count significantly lower than those of the other three populations. Large Lake and Long Lake, the most closely associated lakes of the series, supported populations that do not differ ($P < 0.75$) in number of anal fin rays. A significant difference does occur, however, between the population in Morice Lake and the other four populations.

Discussion

Notemigonus crysoleucas is known to have marked geographical variation in number of anal fin rays although other meristic series appear to be more constant (Hubbs 1921; Scott and Crossman 1973). Consequently, it is not unexpected that the number of dorsal and pelvic rays and the number of scale rows above the lateral line do not vary among the five populations examined, even though their habitats vary in certain limnological characteristics. The number of lateral line scales of the populations of Morice Lake, Long Lake, Large Lake, and Wood's Pond also do not show significant differences and the pooled mean number (46.9) and range (42–49) agree well with the mean (47) and range (42–53) given by

Hubbs (1921) for specimens covering the range of the species. The population in Layton's Lake, the most alkaline and eutrophic lake in the series does, however, possess a significantly lower number of lateral line scales.

The number of anal fin rays, the meristic character in *N. crysoleucas* most susceptible to environmental modification (Hubbs 1921) does show the most extensive variation within the five populations. Long Lake and Large Lake are in the same drainage system and, at the closest point of contact, are separated by only 200 m. Although these lakes differ somewhat in their limnological characteristics, the two populations do not have significant differences in the meristic series examined in this study. Populations that occurred in these lakes in the past would have been eradicated by the inundation of these lakes by salt water as a result of the Saxby Gale of 1869 (Clair and Paterson 1976). Re-colonization of the lakes from sections of the drainage system which escaped the salt-water intrusion could have been from a single population and the limited time and extent of isolation since recolonization could have prevented expression of genetically controlled meristic differences. Morice Lake, which is limnologically similar to both Long Lake and Large Lake but lies in a different drainage system, supports a population of *N. crysoleucas* that has an anal fin ray number that differs significantly from that found in the other four populations. The two most diverse lakes in this series, Wood's Pond and Layton's Lake, contain fish that do not differ in the number of anal fin rays, although the average number is, in both cases, significantly lower than that for the other three lakes.

The correlation between May temperature and anal fin ray number as established by Schultz (1926) would suggest that the May temperature in Wood's Pond and Layton's Lake would have to be about 5.5°C lower than in the other lakes to produce an effect of the observed magnitude if temperature is the factor that brings about the reduced number of anal rays in

these two populations. Available data fail to reveal any obvious differences in the temperatures of comparable water masses in any of the five lakes at any time during the ice-free period. Further, year-to-year fluctuations in water temperature in the region are greater than between lake differences (J. B. Livingstone, unpublished manuscript, Mount Allison University).

The lack of any apparent correlation between number of anal fin rays in the five populations and either the temperature or the other limnological characteristics of the lakes suggest that the observed differences are most probably not the result of obvious environmental differences between the habitats. In addition, the absence of differences in anal ray numbers between the two year classes examined in detail would appear to preclude short-term environmental shifts during critical periods of development as being responsible for the observed population differences, unless it is assumed that such shifts were consistent in timing and intensity for each lake over at least a two-year period. The available data appear to be best interpreted by postulating genetic differences between the populations.

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Unreliability of Strip Aerial Surveys for Estimating Numbers of Wolves on Western Queen Elizabeth Islands, Northwest Territories

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Abstract. Numbers of wolves (*Canis lupus arctos*) were obtained by aerial survey and by ground observation on western Queen Elizabeth Islands, Northwest Territories. Six transect-strip "census" aerial surveys were flown in March-April and July-August of each year from March 1972 to August 1974. The estimates based on aerial surveys were usually misleading. The behavior of observed wolves and their associations with other animals or objects that helped attract the observers attention to the wolves greatly influenced the number of observations. These reported shortcomings of aerial surveys must be considered during any future attempts at determining numbers of wolves.

The so-called Melville Island wolf (*Canis lupus arctos* Pocock, 1935) that occurs on the Queen Elizabeth Islands, Northwest Territories, is the Canadian High Arctic form of the gray wolf, *Canis lupus*. This subspecies has apparently recently in-

vaded Banks Island and replaced the Banks Island tundra wolf, *C. l. bernardi* Anderson, 1943 (Manning and Macpherson 1958). It is likely that *C. l. arctos* now occurs on most or all islands south of Melville Sound, although the Baffin Island tundra wolf *C. l.*

manningi Anderson, 1943, is still apparently found on Baffin Island. The Canadian High Arctic form of *Canis* apparently radiated out from the refugium of Pearyland after the Wisconsin glaciation (Macpherson 1963).

Information on High Arctic wolves is fragmentary, but existing reports (Parry 1821; Belcher 1855; M'Dougall 1857; M'Clintock 1859; Bernier 1910; Stefansson 1921; MacDonald 1954) suggest that historically wolves have not occurred in high numbers on the western Queen Elizabeth Islands. More recent observations (Macpherson 1961; Tener 1963; Riewe 1975) further emphasize the low numbers of wolves even during periods of high prey populations. High Arctic wolves prey mainly on Peary caribou (*Rangifer tarandus pearyi*) and muskoxen (*Ovibos moschatus*). The future of *C. l. arctos* is questionable in view of the recent (1973-74) crash of both prey species and increasing human contact on the western Queen Elizabeth Islands.

Man's activities in the High Arctic will most likely encourage a wider range of wildlife inventories by involved agencies. The most practical method of counting arctic ungulates and large carnivores over

extensive areas is by aerial survey. The "transect-strip census" method is the design most often used for such counts.

We flew six transect-strip aerial surveys between March 1972 and August 1974 to estimate Peary caribou and muskox numbers. Analysis of wolf observations made by us during the surveys shows that attempts to determine wolf numbers by this technique gave disparate estimates. Therefore, we present our observations of wolves obtained from aerial surveys and from additional sightings by observers on the ground in order to draw attention to the variation and possible error that can occur even from intensive (25% coverage) aerial strip surveys.

Survey Area

The Queen Elizabeth Islands included in our surveys are listed in Table 1 by descending order of size. The islands surveyed lie between latitudes 74° and 78° North and longitudes 95° and 124° West. The survey area, except western Melville Island is low-lying and mainly below 150 m elevation. Western Melville Island is mostly mountainous terrain with many sites from 300 m to 1000 m above sea-level. The

TABLE 1—Sightings of wolves on western Queen Elizabeth Islands, Northwest Territories, between March 1972 and August 1974

Islands surveyed	Size of island (km ²)	Wolf sightings					
		1972		1973		1974	
		winter	summer	winter	summer	winter	summer
Melville	42220	15*	0(15)*	9(1)	14(22)	12 (7)	0(26)
Bathurst	16090			1		0 (8)	0
Prince Patrick	15830			1(5)	12 (3)	0(10)	0(25)
Mackenzie King	5100			0		0	
Borden	2790			0			
Eglinton	1550	0	0	0	8	1 (4)	0
Lougheed	1300			0		0	
Byam Martin	1160	2	0	0	0	1	0
Vanier	1130			0		0	
Cameron	1060			0		0	
Brock	790			0			
Emerald	550			0	0	0	
Alexander	490			0		0	
Massey	440			0		0	
Little Cornwallis	410			0		0	0
Helena	330			0		0	
Edmund Walker	82			0		0	
Marc	56			0		0	
Fitzwilliam Owen	34			0		0	
Eight Bears	18			0		0	

*Sightings not in parentheses were obtained from aerial surveys and those sightings in parentheses were made by observers engaged in other activities. No entries (blank spaces) indicate that the islands were not surveyed during that period.

terrain is open and for the most part is suitable for aerial surveys. Locally, broken terrain could hinder observation.

Methods

The islands were surveyed by use of a standard transect survey (Miller and Russell 1974). Surveys were flown on 13 days between 20 March and 7 April 1972, 8 days between 7 August and 24 August 1972, 18 days between 19 March and 15 April 1973, 18 days between 5 July and 21 August 1973, 12 days between 25 March and 17 April 1974, and 17 days between 18 July and 26 August 1974. Parallel flight lines were drawn on 1:250 000 scale topographical maps. In 1972 flight paths were at 6.4-km intervals. In 1973 and 1974 flight paths were also at 6.4-km intervals, except on Mackenzie King, Borden, and Brock islands where they were 12.8 km apart, and on Eglinton and Byam Martin islands the spacing was 3.2 km. The flight lines on Melville Island were oriented either east-west or north-south in each stratum to provide maximum contact with the coast for accurate navigation. Flight lines were oriented east-west on all other islands although on Byam Martin and Eglinton islands, north-south surveys were added to provide double coverage in March-April 1973, then changed to all east-west lines for remaining surveys. A Helio Courier fixed-wing aircraft was used for all surveys, except in August 1972 when a Bell 206 turbo-helicopter was used.

A 1.6-km strip, 0.8 km on each side of the aircraft, was surveyed. The 0.8-km strips were divided into two 0.4-km strips to determine the efficiency of observing within the 1.6-km strip. To mark the boundaries of each strip, wires were strung from an eye-bolt on the

wing to one on the fuselage of the Helio Courier. Lines marked on each observer's window were aligned with corresponding tabs on the wires. At an altitude 150 m above ground, these tabs were checked against fuel drums located at 0.4- and 0.8-km intervals from a reference point on the ground. Allowance was made for the blind spot beneath the aircraft so that an entire 0.8-km strip was visible on each side of the aircraft. Wildlife sightings were recorded as being within the two 0.4-km strips closest to the aircraft, within either of the two 0.4-km strips farthest from the aircraft, or outside both sets of strips (off transect).

All survey flights were flown about 150 m above ground level according to altimeter readings except on western Melville Island where broken terrain forced us higher. Speeds ranged from 110 to 190 km/h, depending on the number of animals encountered. Observations were located on the survey maps and recorded on tape. At the end of each day the sightings were transcribed and located on a second map.

Results and Discussion

The distributions of wolves observed during our six aerial surveys and by observers on the ground are given in Table 1. Table 2 gives numbers of wolves observed on each aerial survey, and estimated densities and numbers of wolves for all the islands and includes sizes of areas surveyed and distances flown. Observations in Table 1 show that during periods when no wolves were seen by aerial survey, wolves were seen by ground observers. Such discrepancies between aerial and ground observations further support the apparent observational error resulting from aerial survey of wolves. Tener (1963) saw 18 wolves during his aerial survey of the entire Queen

TABLE 2—Observed and estimated numbers of wolves on western Queen Elizabeth Islands, Northwest Territories, obtained from six aerial surveys

Survey period	Area surveyed (km ²)	Distance flown (km)	Total wolves seen	Outer strips (total 0.8 km)	Observed density* by strip location (wolves/1000 km ²)			Estimates of total numbers based on widths of strips	
					Inner strips (total 0.8 km)	All strips (total 1.6 km)		0.8 km	1.6 km
Mar.-Apr. 1972	44930	7020	17	0.0	3.0	1.5		135	67
Aug. 1972	26240	4100	0	0.0	0.0	0.0		0	0
Mar.-Apr. 1973	91430	13930	11	1.0	0.0	0.5		0	46
July-Aug. 1973	61310	10000	25**	3.2	0.0	1.6		0	98
July-Aug. 1973	61310	10000	34***	4.2	0.0	2.1		0	129
Mar.-Apr. 1974	50400	7920	14	2.2	0.0	1.1		0	55
July-Aug. 1974	67800	10340	0	0.0	0.0	0.0		0	0

*Density was determined by multiplying distance flown (km) by width of transect strip (km), which equals area censused (km²), then total wolves seen on transect was divided by the area censused: e.g., $7020 \times 0.8 = 5616 \text{ km}^2$, then $17/5616 = 0.003 \text{ wolves/km}^2$ or $3.0 \text{ wolves/1000 km}^2$.

**Observations do not include newborn pups.

***Total wolves seen includes nine newborn pups.

Elizabeth Group in summer 1961 and only three of those wolves were on western Queen Elizabeth Islands. Coverage was only 6% for the 1961 survey. At that time on the western islands Peary caribou were estimated to number 24 320, about 10 times as numerous as we estimated in 1974 (2676). Muskoxen occurred at similarly estimated numbers (2161 in 1961 and 2704 in 1974).

Of the 202 total sightings of wolves made both from the air and from the ground between March 1972 and August 1974 (Table 1), 69% (140) wolves were seen in 24 packs. Pack size averaged 5.8 and ranged from 2 to 15. Twenty-four percent (49) of the wolves seen were in six family groups of adults and pups, five groups in summer 1973 and only one in summer 1974. Family groups averaged 4.2 adults/4.0 pups, and adults/pups varied as follows: 2/5, 3/2, 4/2, 5/1, 5/10, and 6/4. Two dens were found on Melville Island and one on Prince Patrick Island in 1973. Only the den on Prince Patrick Island was occupied in summer 1974. Only 6% (13) of the wolves seen were solitary. Of all the wolves seen (Table 1) 14% were stalking muskoxen, 12% were feeding on muskox carcasses, 9% were stalking caribou, 17% were at wolf dens, 17% were travelling and not associated with anything that would have helped to attract our attention to them, and 31% were seen at permanent or temporary camp sites.

Only 76 wolves were seen on 53 310 km of flight paths during the six aerial surveys (Tables 1 and 2): 53% were in packs, 35% were in family groups (20% at den sites), and 12% were solitary wolves. Of the 76 wolves seen, 28% (21) were stalking muskoxen, 22% (17) were feeding on muskox carcasses, 3% (2) were stalking caribou, 35% (27) were in family groups (15 at den sites and 12 travelling cross-country), and 12% (9) were travelling and not associated with any other animals or objects.

The variations in the estimates (Table 2) established the inaccuracy of the estimates, but we are unable to calculate correction factors as we cannot verify the accuracy of any of the estimates. Our inability to determine how many of the wolves sighted by ground observers represented different individuals prohibits the establishment of a ratio of wolves seen from the ground to wolves seen from the air. Such a ratio would have allowed evaluation of errors in the estimates obtained from aerial surveys. It is clear, however, that transect-strip aerial surveys are not reliable for determining wolf populations on the open tundra of the High Arctic.

Some of the problems inherent in aerial surveys of large mammals (Graham and Bell 1969) particularly apply to our surveys of wolves. The size and relative lack of color contrast between pelage and background, especially in winter, reduce the visibility of wolves from the air. In addition the behavior of the

wolves can influence their chances of being seen from the air. Although we do not have quantitative measurements, ground observations of wolves reveal that wolves will sometimes remain stationary during overflights by aircraft. The effect that arbitrary selection of transect strip widths has on subsequent estimation is shown in the estimates by strip width (Table 2). We cannot explain the unexpected pattern of occurrence of wolves on the outer and inner strips (Table 2). Our results do not follow the expected pattern of most observations of inconspicuous animals on narrow transects (Pennycuik 1969). We suggest that some wolves had moved from the inner to the outer strips before being sighted and/or remained stationary on the inner strips and were not sighted.

These conditions and the above factors, and possibly many more, contribute to confounding the observations of wolves by aerial survey.

Our consistently low counts of wolves do suggest that wolves are in low numbers throughout the western Queen Elizabeth Islands. The current numbers of Peary caribou and muskoxen could not sustain high numbers of wolves, and alternate food sources are often scarce.

It is our opinion, however, that even the number of wolves seen on each aerial survey is not necessarily representative of the true number of wolves present. Therefore, resultant estimates would often be erroneous; this condition must be borne in mind by future observers.

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The Flowering Phenology of Common Vascular Plants at Bailey Point, Melville Island, Northwest Territories

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A collection of the vascular flora at Bailey Point, Melville Island (74°58' N, 115°01' W) was made during the course of studies of caribou (*Rangifer tarandus pearyi*) and muskoxen (*Ovibos moschatus*) from 24 June to 20 August 1974. That collection is preserved in the Vascular Plant Herbarium of the Biosystematics Research Institute, Ottawa. Cody et al. (1976) have reported on new additions to the vascular flora of Melville Island resulting from the collection.

Throughout the period of observation, notes were kept on when the most common plants came into flower, the period of peak bloom, and when the last flowers of a species were seen. A search of the literature showed a paucity of information on the flowering phenology of vascular plants in the high Arctic. Existing records usually include the date of first flower for a few species only (Savile 1959, 1961, 1964; Parmelee 1963; Beschel 1963). Bruggemann and

Calder (1953) provide a useful comparison of first-flowering dates for 16 vascular species at four locations in the Canadian Arctic.

Records of flowering periods are useful in documenting species differences in phenology during a single growing season at specific locations. Broader regional differences in phenology may become apparent when more data become available. Such records are also useful to those persons planning to study certain species in specific northern locations.

The period of flower, with approximate date of peak bloom, is shown in Figure 1 for the most common and conspicuous vascular plants at Bailey Point from 28 June to 15 August 1974.

The first vascular plant in flower was *Saxifraga oppositifolia*; the last to appear was *Senecio congestus*. The period when the most species were in peak flower was 18 to 25 July. The degree of habitat

tively, from 1951 to 1960 (Thompson 1967). Mould Bay is on Prince Patrick Island, approximately 150 km northwest of Bailey Point. Savile (1961) reported that 1960 was a typical growing season. He (Savile 1971) also suggested the better plant growth at Mould Bay may be explained by the greater number of sunshine hours there than at Isachsen.

In 1974 mean temperatures for June and July at Mould Bay were -1.8°C and 2.0°C ; this suggests that an abnormally cool month of June delayed plant development and subsequent flowering dates at Bailey Point by as much as 10 to 14 days.

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Gestation, Litter Size, and Number of Litters of the Red Squirrel (*Tamiasciurus hudsonicus*) in Quebec

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In the course of ethological studies at the Station de Biologie de l'Université de Montréal, at St. Hippolyte, Quebec, from November 1971 to October 1974, information concerning the reproductive biology of *Tamiasciurus hudsonicus* in eastern Canada was gathered by the authors.

Daily observation of captive squirrels (three males and three females) in a large outdoor enclosure (2.4 m high with a floor surface of 4.5×3.7 m) allowed one of us (J. F.) to record the exact day of copulation for one female, 10 April 1973 between 1300 and 1400 hours, and of parturition 35 days later on 15 May 1973 between 0000 and 0700 hours. That the female mated only on 10 April is in agreement with Smith (1968) who found that the oestrous female red squirrel is receptive for only 1 day. This is the first direct observation of the length of the gestation period for *T. hudsonicus*; it is shorter than the approximation of 40 days given by Hamilton (1939).

Between June 1972 and August 1974 seven gravid

female red squirrels were live-trapped at St. Hippolyte. They were placed in individual wire cages until parturition. They gave birth to 38 young (Table 1). The average litter size at birth was 5.4 (range 4 to 8, $N = 7$); this is higher than 3.2 ($N = 9$, based on nest young) observed by Davis (1969), 3.9 ($N = 82$, based on placental scars) by Kemp and Keith (1970), 4.5 ($N = 74$, based on placental scars, embryos, nest young) by Layne (1954), 4.4 ($N = 83$, based on corpora lutea counts) by Millar (1970), 3.3 ($N = 24$, based on placental scars, embryos, nest young) by Smith (1968), and 4.0 ($N = 20$, based on placental scars) by Wood (1967).

From Table 1, a sex ratio at birth was calculated. We found a ratio of 1.37 males to 1.00 females ($N = 38$); this does not differ significantly from 1:1 ratio ($\chi^2 = 0.97$, $P > 0.05$). Davis (1969) also found a sex ratio of 1:1 at birth for *T. hudsonicus* in Saskatchewan.

From year-round observation of females in the wild

TABLE 1—Date of birth and litter composition of *Tamiasciurus hudsonicus* at St. Hippolyte, Quebec. Young were counted and sexed shortly after parturition

Date of birth	Number of young		
	♂♂	♀♀	Total
2 June 1972	3	2	5
25 April 1973	3	2	5
28 April 1973	3	2	5
11 May 1974	2	2	4
2 June 1974	4	0	4
9 July 1974	6	1	7
31 July 1974	1	7	8
Total	22	16	38

and in a captive group kept under semi-natural conditions, it appears that females have only one litter per year. Wrigley (1969) suggests the existence of two breeding seasons in southern Quebec but did not have any observations of individuals having two litters per year. Layne (1954), however, found that in eastern United States red squirrels frequently produce two litters a year. In the northwestern part of North America, only one litter per year has been reported by Davis (1969), Dolbeer (1973), Hatt (1943), Kemp and Keith (1970), Smith (1968), Soper (1942), and Wood (1967). The short length of the mild season in northern regions and at high elevations probably limits production to one litter per year. This is supported by Millar (1970) who recorded two litters in British Columbia during a particularly mild year, and one litter during a normal colder year.

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The Fern *Woodsia obtusa* (Spreng.) Torrey in Ontario

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The author, in the company of M. Coulthart, visited Frontenac Provincial Park north of Kingston on 30 July 1975, in an attempt to find *Asplenium trichomanes* L. growing together with *A. platyneuron* Oakes. It was a hot summer day and we noted that *Cystopteris fragilis* Bernh. growing in rocky crevices appeared completely brown and dead from the prolonged summer drought. As we were returning to the

car after walking along the shore of Black Lake immediately to the west of Devil's Lake in Bedford Township, Frontenac County, we crossed a rough wall of granite boulders and a frond of a fern that was completely green caught my attention in amongst the dead fronds of *C. fragilis*. It looked like *Woodsia obtusa*, but this species is considered to be absent from Ontario (Lafontaine 1973); it was carefully put in a

press for study back at Guelph. This specimen, *Britton 3584* (OAC), indeed proved to be *Woodsia obtusa* (Spreng.) Torrey.

The author returned to the location on 2 September 1975 with A. C. Jermy, British Museum (Natural History) in order to ascertain how many plants were present, decide if the species was native or introduced to the area, see if there were other colonies near by, and take photographs. We were able to count approximately 12 distinct clones growing in and under granite boulders and the colony covered a narrow band of about 46 m (50 yards) in length. The plants were in the semi-shade of *Fraxinus americana*, *Carya ovata*, *Xanthoxylum americanum*, and small *Ulmus americana*. The young trees appeared to be about 15–20 years old, and the *Woodsia* appeared to be well established under their canopy. Our impression was that the species was adventive to the area in the same sense that *Asplenium platyneuron* grows in disturbed or young second-growth sites, but at the same time the *Woodsia* is now well established, the colony being perhaps 10 years old. A specimen, *Jermy 12424* (BM), was collected.

Woodsia obtusa is a very common species in north-eastern United States extending north to southern Maine, southern Quebec (Lafontaine 1973), New York, and Ohio. Brown (1964) commented that in a greenhouse it "grew like a weed and propagated itself over the benches, even growing in the cinders," quite unlike the other species of *Woodsia* which are difficult to cultivate. Wherry (1961) notes that it grows on various rocks, often invading masonry, the soil circumneutral to subacid. The species has been somewhat of a mystery plant in Ontario. There are two sheets in QK. One is from the herbarium of J. Macoun (Acc. No. 02736) and the other is labeled Ex.

Coll. Nicol (Acc. No. 2735), but neither sheet has any locality data. Naturalists have been puzzled by the pictures in *Native ferns of eastern North America* (Metcalf 1963) with the caption "In Ontario the Obtuse *Woodsia* is much rarer than the rusty one." The query has been raised as to whether this picture is really of *Woodsia oregana* var. *cathartiana*, which is fairly abundant on Manitoulin Island, or did Metcalfe know of a colony of *W. obtusa* in Ontario?

One might speculate that the range of *Woodsia obtusa* does expand into Ontario in periods of warmer winters and has done so in the past. It could be exhibiting the same characteristics as does another southern species, *Asplenium platyneuron* which seems to be occurring at more and more Ontario stations in recent years; it is now known from five sites in Norfolk County and has recently been collected in Elgin County, Brant County, and Waterloo County. In each case it appears to be a recent arrival.

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First Report of the Tiger Trout Hybrid, *Salmo trutta* Linnaeus \times *Salvelinus fontinalis* (Mitchill), in Alberta

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The tiger trout hybrid (*Salmo trutta* Linnaeus \times *Salvelinus fontinalis* (Mitchill)) occurs rarely under natural conditions (Brown 1966). Although there is evidence of ecological and reproductive segregation of the brown trout (*Salmo trutta*) and the brook trout (*Salvelinus fontinalis*) there are areas in streams where the two species intermix, particularly

during the coincidental spawning seasons in late October and early November (Marshall and MacCrimmon 1970; Nyman 1970; Vincent and Miller 1969). Although the opportunity for natural hybridization may be fairly frequent, hybrids are rarely taken because of low fertility and survival of offspring (Buss and Wright 1956; Seguin 1957). The tiger trout hybrid



FIGURE 1. Tiger trout hybrid (*Salmo trutta* × *Salvelinus fontinalis*) taken from the North Raven River on 4 October 1974.

has not previously been reported for Alberta (Paetz and Nelson 1970; Scott and Crossman 1973), though there are a number of streams where the brown trout and brook trout occur sympatrically. The North Raven River (52°10' N, 114°41' W) has the highest known populations in Alberta (i.e., in excess of 800 trout per kilometre in some sections, according to C. Shirvell (1972. Survey of Stauffer Creek and habitat program. Fish and Wildlife Division, Alberta Department of Lands and Forests Manuscript Report. 109 pp.)). Since 1972 over 11 000 specimens of both species have been examined during studies of this stream. No trout have been introduced to the North Raven River since 1950 and no hybridization experiments have taken place at the Raven Rearing Station (J. C. Barnhardt, personal communication).

On 4 October 1974 a single specimen, presumed of the tiger trout hybrid, was taken from the North Raven River by electrofishing (Figure 1). The specimen was 120 mm in fork length, weighed 23.2 g, and was 1+ years old. It was golden-brown with broad, dark brown vertical vermiculations on the lateral surfaces, which extended from the opercula to the caudal penduncle. The dorsal and adipose fins had irregular dark brown spots. Some meristics for the specimen are as follows: teeth on both the head and shaft of the vomer; gill rakers 15; branchiostegal rays 9; pelvic fin rays 9; pectoral fin rays 12; main dorsal fin rays 11; scales one row above lateral line 162; scales above lateral line to posterior insertion of dorsal fin 31.

The specimen's characteristics correspond to the photographs and description of the tiger trout hybrid given by Buss and Wright (1956, 1958) and Brown (1966). A. C. Sinclair, Superintendent of the Sam Livingston Fish Hatchery, Calgary, Alberta and J. S.

Nelson, University of Alberta, Edmonton, Alberta confirmed the identification. The specimen is in the fish collection at the Sam Livingston Hatchery.

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The Cattle Egret in British Columbia

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The recent range expansion of the Cattle Egret (*Bubulcus ibis*) in North America has aroused wide interest. Since its arrival in Florida in the early 1940s (Palmer 1962), the species has been recorded in nearly all American states and Canadian provinces, and is a well established breeder in the southeastern United States (Rice 1956; Davis 1960; Blake 1961; Crosby 1972); it has also bred locally west of the Rockies, in southern California (Small 1974), and New Mexico (Witzeman et al. 1975). Cattle Egrets have now extended their range in western North America into British Columbia. This note reports 17 sightings for the province, involving at least 11 or 12 different birds; two of these are supported by specimens and another four by photographs (see Campbell and Stirling 1971). Table 1 lists all known records of Cattle Egrets for British Columbia. Details of all records are on file

at the British Columbia Provincial Museum.

The 1970 reports are questionable since two observations remain unconfirmed, and for the third (12 December) there was some uncertainty over the identification. The Lower Mainland records therefore were not listed by Campbell et al. (1972) although detailed field notes by the Webers strongly suggest a Cattle Egret. The first positive record for the province was on 19 November 1973 when the Goodwills obtained a roll of 16-mm color movie film of a Cattle Egret probing for food in manure in a pasture field with sheep and cattle.

All records in 1973 and 1975 were from the vicinity of Vancouver Island, whereas 1974 reports were from widely separated localities. Egrets most often associated with domestic stock (cattle, sheep, horses, and even chickens) in farming areas (e.g., Saseenos, Oyster

TABLE 1—Records of Cattle Egrets in British Columbia. sVI = southern Vancouver Island; LM = Lower Mainland (Vancouver area); wcVI = west coast Vancouver Island; scINT = south-central Interior British Columbia; ecVI = east coast Vancouver Island; BCPM = British Columbia Provincial Museum

Date	Locality	Area	Observer	Documentation
26 Nov. 1970	West of Victoria	sVI	<i>vide</i> W. J. Schick	Unconfirmed
12 Dec. 1970	Iona Island	LM	W. C. Weber; R. R. Weber	Field notes
21 Dec. 1970	Lulu Island	LM	B. Gladstone	Unconfirmed
15–19 Nov. 1973	Saseenos	sVI	A. Wickheim; J. E. V. Goodwill; M. Goodwill	Photo; BCPM 371
8 Dec. 1973	Tofino	wcVI	<i>vide</i> A. Dorst	Verbal description
15 Dec. 1973	Stubbs Island	wcVI	<i>vide</i> A. Dorst	Verbal description
19 Nov. 1974	Lake Cowichan	sVI	A. Allan	Specimen; BCPM 14518
21 Nov. 1974	Pachena Point	wcVI	F. G. Hart; R. Noble	Photo; BCPM 372
22 Nov. 1974	Salmon Arm	scINT	W. D. Munro	
16–31 Dec. 1974	Pitt Meadows	LM	B. vanDrimmelin; D. McDermott; S. H. Robinson; W. C. Weber; D. M. Mark	Photo; BCPM 412
21 Dec. 1974	Burnaby Lake	LM	S. Mooney; B. P. Watts	Field notes
22 Dec. 1974	Mud Bay	LM	H. Lamb; G. Brattman; D. Clifford	Field notes
7 Jan. 1975	Denman Island	ecVI	W. Fitzpatrick	Specimen; BCPM 14519
23–26 Nov. 1975	Saseenos	sVI	A. Wickheim; J. E. V. and M. Goodwill; M. G. Shepard; J. E. Williams	Photo; BCPM 425
24–29 Nov. 1975	Sooke	sVI	P. E. Wilford	Verbal description
27 Nov.–6 Dec. 1975	Oyster River	ecVI	D. Wilson	Verbal description
8–14 Dec. 1975	Nanaimo	ecVI	K. Kennedy; L. Dyke	Field notes

River, Denman Island, Lake Cowichan) where they often caught insects attracted to the animals and their droppings, and also probed manure piles for food items. Birds at Pachena Point and Nanaimo even foraged on lawns and in gardens.

Both specimen records were from birds picked up dead and brought to the Provincial Museum for examination. The egrets weighed 212 g and 236 g, well below weights of 300–400 g cited by Palmer (1962). Also, the stomachs were empty, which suggests the birds may have died of starvation after long-distance flights.

In summary, all records to date of the Cattle Egret in British Columbia are from the south coastal region, except for one sighting in the southern interior at Salmon Arm. The three 1970 records and three 1973 records could, in each case, conceivably have resulted from a single wide-ranging individual. At least five, but more likely six, birds were involved in the 1974 records, and at least four, but more likely five, in the 1975 records.

All British Columbia records have been of single birds in late fall and early winter (extreme dates 15 November and 7 January). This closely follows the pattern of sightings in Oregon and Washington. The "Seasonal Reports" in *Audubon Field Notes* and *American Birds* list six records of Cattle Egrets for Oregon from 1965 to 1975, ranging in date from 22 November to 17 January, with a single record on 1 March 1975, which may involve a bird that successfully wintered. In Washington, there have been five records (including an unconfirmed report in 1969), spanning the period 10 October to 8 January.

In the absence of banding recoveries, the origin of British Columbia birds is uncertain, but the most likely route of dispersal is directly up the Pacific coast

from breeding areas in California or even in western Mexico. This hypothesis is supported by the fact that 6 of the 11 Oregon and Washington records are from the outer coast. But, even if the British Columbia birds came from the nearest Cattle Egret breeding colony at the Salton Sea in southern California, they must have travelled a minimum of 1850 km from where they were hatched.

We thank the numerous observers who provided us with field notes, photographs, and specimens of Cattle Egrets; also Jerome A. Jackson, Anthony J. Erskine and J. E. V. Goodwill for their comments on the manuscript.

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A Great Blue Heron Preying on Shiner Perch in Deep Water

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Hérons feed primarily on fish, and feeding methods common to all species are typically the "stand and wait" and "wade or walk slowly" behavior patterns (Lowe 1954; Meyerrieks 1960, 1962). Such aspects of feeding behavior are generally restricted to herons foraging in relatively shallow waters. I observed a Great Blue Heron (*Ardea herodias* L.) preying on shiner perch (*Cymatogaster aggregata* Gibbons) in

deep water, and in this note I describe its feeding behavior and present quantitative estimates of its feeding efficiency.

Observations and Discussion

On the afternoon of 20 September 1975, a yearling Great Blue Heron (based on Palmer's (1962) criteria) was seen landing on a floating platform near the wharf

of the Pacific Biological Station, Departure Bay, British Columbia. Throughout the afternoon, the sky remained clear and sunny, the air temperature was about 20°C, and the water surface was calm. The platform (about 9 × 5 m), floating in about 10 m of water, was open except for a few planks extending across its length and width and suspended about 20 cm above the water surface. Before the heron left the wharf area, a total of 95 min of observation was made with the aid of stopwatches and a camera from within a docked boat about 7 m away from the platform. My presence did not appear to influence the heron's activities. Approximately 5 min after its arrival, the heron began preying on fish swimming in the water enclosed by the platform. Since I could not see the fish from my vantage point, the heron's feeding postures, described in the following paragraph, are assumed to have been displayed in response to the movements of the fish. The fish were later identified as yearling shiner perch (approximately 5–9 cm total length). Assuming a mean length of 7 cm for the observed fish, an estimated mean wet weight of 5 g per individual was obtained, from Gordon's (1965) length–weight relationships. The perch were aggregated (60–80 individuals) near (about 0–1 m) the water surface, feeding on plankton in shadows created by the overhead planks.

When not walking on the planks in the "wade or walk slowly" or "low stalk" (Recher and Recher 1972) postures, the heron was generally observed to be in the "stand and wait" posture. The bird remained in this posture until prey was sighted. With its eyes fixed on the perch, the heron followed its movements with compensating eye and head movements but rarely moved other body parts. As the fish apparently approached to within 1 m or so of the bird, the latter's long body axis slowly and gradually shifted downward and forward in the direction of the water surface with simultaneous uncoiling of the neck and bending of the legs. These gradual changes in head and body orientation are similar to those typically exhibited by feeding herons, excepting that the body of the bird was more steeply angled downward relative to the horizontal, owing to the higher position of the feet (20 cm above, rather than 0–20 cm below, the water surface). After the downward inclinations of its head and body, the heron either adopted a more erect posture or quickly exhibited a "strike" with its bill at the nearby perch.

A very important factor in an animal's feeding ecology, contributing to its survival and reproductive success, is feeding or foraging efficiency. Two commonly used estimates of this efficiency are percentage capture success and food ration consumed per individual. During its 95-min feeding period, the Great Blue Heron had a 90.3% capture success (i.e.,

captured and consumed 28 perch out of 31 "strike" attempts), and consumed 1.47 g of prey per minute. Krebs (1974) observed a capture success of about $41.0 \pm 3.5\%$ (± 1 SE) and a food consumption rate of about 1.5 ± 0.15 g/min for solitary (non-flocked) adult Great Blue Herons feeding on a variety of intertidal fish species, including shiner perch. For aggregated (flocked) herons, he reported individual capture successes ranging from about 45.0 ± 3.5 to $68.5 \pm 5.5\%$ and food consumption rates ranging from about 1.55 ± 0.15 to 5.15 ± 1.35 g/min. Recher and Recher (1969) reported a capture success of 64–75% with 0.3–0.7 g of prey consumed per minute for the Little Blue Heron (*Florida caerulea*). Later, Recher and Recher (1972) reported similar estimates (64–67% and 0.7 g of prey consumed per minute) for the same species, and a 48% capture success with 0.3–0.4 g of prey consumed per minute for the Reef Heron (*Egretta sacra*). A capture success of 90–97% (Siegfried 1971) associated with 0.13–0.51 g of prey consumed per minute (Siegfried 1972) has been documented for the Cattle Egret (*Ardeola ibis*). These values of feeding efficiency were obtained for herons feeding in shallow waters, in pastures, or on flats.

Although herons generally feed in shallow waters, some species have evolved specialized behavior patterns to prey on organisms in deep waters, especially when prey availability is high there (Meyerriecks 1962). Diving or swimming (or both) after prey has been observed in the Common Heron, *Ardea cinerea* (Lowe 1954; Stacey and Gervis 1967), in the Green Heron, *Butorides virescens* (Meyerriecks 1960), and in the Great Blue Heron (Bent 1926). These deep-water feeding methods, however, do not appear to be very successful (Stacey and Gervis 1967). Palmer (1962) mentioned that the Great Blue Heron "occasionally fishes on the wing," but failed to provide further details. In reviewing the literature on the Green Heron, Meyerriecks (1960) reported that this species may feed in deep water by remaining stationary on structures such as logs, posts, or a rowboat, on which it either remains crouched with head and neck retracted or extends its head and neck downward toward the water, or alternatively by diving into the water from a plank, the edge of a park pool, or the shore of a pond or stream. He did not mention how successful these various feeding adaptations were.

This paper is the first to my knowledge which presents quantitative estimates of the feeding efficiency of a Great Blue Heron feeding on fish in deep water. The behavioral postures reported here do not differ radically from those displayed by herons using the typical "stand and wait" feeding method while foraging in shallow waters, except for the greater downward head and body inclinations; these may be considered adaptive for feeding from structures

elevated above the water surface. The food consumption rates of solitary Great Blue Herons reported by Krebs (1974) are very similar to the one presented here, but the 90.3% capture success of the heron feeding on perch in deep water is much greater than the capture successes of both solitary and aggregated herons feeding on a diversity of fish species in shallow, intertidal waters (Krebs 1974). Including the 90–97% capture success reported for Cattle Egrets foraging mainly on terrestrial arthropods (Siegfried 1971) and the high fish consumption rates reported for aggregated Great Blue Herons (Krebs 1974), the feeding efficiency values presented here appear to be the highest reported for Great Blue Heron and other heron species. These observations suggest that the Great Blue Heron can be an opportunistic and efficient predator.

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Spotted Redshank Sighted in Southern Ontario

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On 25 July 1976 we found and identified a Spotted Redshank (*Tringa erythropus*) on a pond near Queenston, Ontario (the pond was closer to the small town of St. Davids, 43° 10' N, 79° 06' W). W. E. Godfrey (1966. The birds of Canada. National Museum of Canada Bulletin 203. 428 pp.) cites a single hypothetical Canadian record for the Redshank (*Tringa totanus*) and notes that the bird might have been a Spotted Redshank. In a private communication to the authors, Godfrey writes "There was no valid record of the Spotted Redshank for Canada until 1970. In the autumn of that year positively identifiable photos were taken of one at the Reifel Waterfowl Refuge, near Vancouver, B.C. (Campbell, R. W., M. G. Shepard, and R. H. Drent. Syesis 5: 151–152, 1971). There is also a sight record of one at the same locality in early May 1971 (American Birds 25(4): 791, 1971). Another sight record is from

Newman Sound, Terra Nova National Park, Newfoundland, where one was observed from May 15 to 21, 1974 (Finch, D. W. American Birds 29(1): 127, 1975). This specimen was in breeding plumage and therefore presumably unmistakable."

In view of the exceptional rarity of the Spotted Redshank in Canada, and the excellent opportunity we had to observe the bird, we present a summary of our visual observations in this note. For a more detailed account the reader is referred to a report submitted by one of us (H. H. A.) to the Buffalo Ornithological Society* and to the Ontario Ornithological Records Committee.**

*Buffalo Ornithological Society, Buffalo Museum of Science, Buffalo, New York, USA.

**Sent to: C. E. Goodwin, 11 Westbank Crescent, Weston, Ontario. We understand that at least one other report on the Spotted Redshank was filed with this committee.

The bird was first seen under clear skies at about 1100 hours in a telescope at 20-power. It was at a distance of about 140 m, and was in a settling pond operated by Canadian Cannery. This pond is a new one and in places there is water to a depth of 8 or 10 cm, whereas in other places there is no water at all, only bare earth. A 3-m dike surrounds the pond which is about 275 m long and 120 m wide. About 100 Lesser Yellowlegs (*Tringa flavipes*) and 25 dowitchers (*Limnodromus* sp.) were present along with several hundred smaller shorebirds.

The feature of the bird which first attracted our attention was a long bill with a red base. The bill length was about twice the size of the head and noticeably longer, in proportion to the head, than the bills of Lesser Yellowlegs in the same field of view of the telescope. The basal red extended a little less than half the bill length, and at 60-power a dusky strip on the top of the upper mandible was observed to parallel the red region. The bird was only slightly larger than the Lesser Yellowlegs, and when not standing beside a Lesser Yellowlegs was not separable from these by size alone. The bill was as slender, in proportion to the head, as the bills of the Lesser Yellowlegs.

We were startled when the bird moved to shallow water and its red legs became visible. The color was easily seen at 20-power. In fact later in the day, when the bird was about 275 m from us, the leg color and the basal bill color could be seen with 40-power.

A final striking field mark, visible in binoculars at 140 m, was the white which extended from the rump up the back in a manner similar to the pattern found in dowitchers. The white was seen on several occasions when the bird flew, and on at least one occasion when the bird preened. It was clearly visible when the bird left the pond at about 1700 hours. (Although a number of people have looked for the bird since that time, it has not been reported at St. Davids.) Before

leaving the pond, the bird flew over it at a height of about 9 m repeatedly uttering a call that some observers said resembled a Semipalmated Plover (*Charadrius semipalmatus*) call.

If one accepts the clearly visible field mark of the red legs then the only birds known in North America that could qualify as the bird seen are the Redshank and Spotted Redshank. There are several field marks that support the latter choice. First, there was no sign of the white hind edges of the wings said to characterize the Redshank. Second, underparts of the bird were very much darker than those depicted for the Redshank in *A field guide to the birds of Britain and Europe* (Peterson, R. T., G. Mountford, and P. A. D. Hollom. 1966. Houghton Mifflin Company, Boston. 344 pp.). There was considerable dark mottling on the underparts of the bird. Finally, there was the long bill, substantially longer in proportion to the head than the bills of the Lesser Yellowlegs; this one expects for the Spotted Redshank. Although a very heavily oiled bird might not show the white hind edges of the wing, and would show overall dark appearance, it might also have oil on the rump and back that was not observed. The plumage, in fact, seemed to be one in transition between the summer and winter phases of Spotted Redshanks depicted in the field guide.

Although we believe in general that a good photographic record should be given more credence than visual observations, the field marks of this particular bird, and the excellent opportunity we had for careful and lengthy observation, make this record one of the most credible of visual observations. At least seven other adult bird watchers saw the bird, and all easily saw the red legs.

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Fieldfare in Ontario¹

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On the morning of 24 May 1975, M. J. Porter heard the distinctive calls of a Fieldfare (*Turdus pilaris*) at the Long Point Bird Observatory's station on Courtright Ridge, Long Point, Ontario (42°33' N,

80°17' W). He saw the bird in the treetops and, being familiar with the species in Europe, was able to identify it immediately. Half an hour later Alex Steele found the Fieldfare caught in a mist net which he and Porter had set alongside some spruce and pine trees. Plumage details were recorded and it was banded,

¹A publication of the Long Point Bird Observatory.

weighed, and measured. The bird was then taken to the mainland, where it was photographed (Figure 1) and examined in greater detail by D. J. T. Hussell and several other people, including M. Bradstreet, E. H. Dunn, G. W. Miller, J. Woodford, and P. S. Woodford. When it was released later the same day, the Fieldfare called and flew to a nearby tree, where it was watched for a few minutes. It was not seen again.

The bird was a large thrush, similar in size and build to an American Robin (*Turdus migratorius*), and identified by its gray head and rump, chestnut back, and speckled breast. The wing chord measured 139 mm, indicating that it was probably a female (males 140–153 mm, females 135–148 mm, Witherby et al. 1940). A detailed description, including measurements, and copies of color slides have been deposited with the Ontario Ornithological Records Committee at the Royal Ontario Museum.

There was no indication that the bird had recently

been in captivity. The legs, feet, and wings were examined carefully for wear and found to be in good condition. The tips of the tail feathers were somewhat worn, but the ends of the shafts were intact, projecting slightly beyond the webs.

The summer range of the Fieldfare extends from south-central Siberia west to Scandinavia and south to Switzerland and Hungary, with recently established outpost populations in southwestern Greenland (Voous 1960) and the British Isles (Williamson 1975). Fieldfares winter mainly in southern and central Europe, including the British Isles (Witherby et al. 1940).

Previous North American records include specimens from Stamford, Connecticut (April 1878) and Jens Munk Island in Foxe Basin, NWT (1939); a photograph from St. John's, Newfoundland (1 January 1973); sight records at Ottawa, Ontario (8 January 1967), Bombay Hook, Delaware (30 March–4 April 1969), and Larchmont, New York (3–11 February 1973) (Finch 1973). The origin of these North American birds is a matter of speculation. Salomonsen (1951) says that the Greenland breeders are sedentary, implying that they do not migrate east across the Atlantic to winter in the Old World. The recent records suggest the possibility of the development of a pattern of regular wintering in North America by a portion of the Greenland population.

The present record is the first for Ontario to be documented with material evidence (photograph), and as such it constitutes an addition to the Ontario list accepted by the Ontario Ornithological Records Committee (C. E. Goodwin, personal communication).

We thank the members and employees of the Long Point Company for facilitating the operation of the Observatory's station on Courtright Ridge. A. D. Brewer and C. E. Goodwin commented on an earlier draft of the manuscript, and D. W. Finch provided information on previous North American records.

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FIGURE 1. Fieldfare, Long Point, 24 May 1975. From a color slide by Isabel Smaller.

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Genetic Variants in Canada of the Rainbow Trout, *Salmo gairdneri*, Called Golden Trout and Palomino Trout

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Prior to 1974 specimens of an interesting variety of rainbow trout (*Salmo gairdneri*), generally referred to by anglers as "golden trout," had been irregularly taken in USA waters of Lake Erie and the Buffalo-Niagara River area of New York State (R. B. Kenyon, personal communication). These unique trout are not to be confused with the true golden trout, *Salmo aquabonita* Jordan. "Golden trout" were first recorded from Ontario waters in 1974. The first specimens reported were taken by anglers from the Upper Niagara River just upstream from the city of Niagara Falls. These fish were marked with a left pelvic-fin clip.

The origin of these variants was traced to Pennsylvania. They had been reared and released into Lake Erie and its tributaries, as part of a cooperative program involving the Pennsylvania Fish Commission and the 3CU Trout Association (a sportsmen's group). Two rainbow variants had been reared and released. These were known as "golden trout" (golden-orange in color, without black spots) and "palomino trout" (golden in color with a reduced number of faint black spots as compared with normal rainbow trout).

In 1975 at least eight variant trouts were taken in Ontario waters: May, two golden trout in commercial nets from Lake Ontario, 1.6 km (1 mi) west of the mouth of Niagara River, left pelvic clips; May, one palomino trout in commercial nets from Lake Ontario, near Grimsby, Pennsylvania, tag; September, one golden trout in commercial nets from Lake Erie, 1.6 km (1 mi) east of Port Dover, left pelvic clip; October, one golden trout and one palomino trout, Ontario Ministry of Natural Resources crew, Ontario Hydro diversion canal, Niagara Falls, left pelvic clip.

The tagged individual caught in Lake Ontario near Grimsby had been hatched in May 1972. It had been released (at length of 175–225 mm) into Lake Erie off the mouth of a tributary stream, Trout Run, on 4 April 1975. The Pennsylvania records referred to this individual as a "Palomino Steelhead Rainbow Trout."

The name golden trout as used by the anglers was derived from the unique color, since the anglers were unable to recognize them as rainbow trout, *Salmo gairdneri*. "Golden trout" was also the name given

these fish in the original genetic experiment from which they were developed. The golden color is a combination of genetic effects on background color, resulting from color dilution because of an absence of melanophores.

The "golden" trout are basically orange-gold (O-17-10°) (see Villalobos-Dominquez and Villalobos 1947) on the back. The sides are golden to silvery with a darker orange lateral band (SO-17-9°). The opercles and cheeks are reddish orange (SSO-14-10°), and the lower sides and belly milk white. The dorsal, adipose, and caudal fins are yellow. The anal fin appears to lack color. The paired fins are yellow with an orange leading edge. The "palomino" trout have the same overall coloring as the "golden" trout (sometimes darker) but show a pattern of black spots on the head, back, and caudal fin. The caudal spotting is more predominant on the upper lobe. The spotting is much reduced (number, size, and density) from that of normal rainbow trout. The palomino trout seen in Ontario appear to have more spots than indicated by the illustration of that variant given by Wright (1972).

Values for almost all morphometric characters for those examined fell within the central range of the values for *Salmo gairdneri*. The exception was gill rakers which were at the lower limit (9 on upper, 10–11 on lower). The specimen taken near Port Dover in September 1975 was a male with greatly enlarged white testes. Maximum total length of those seen has been 45.3 cm and maximum weight 1.15 kg at age 1+. At least some individuals appear sexually mature at this size and age. According to Wright (1972) this "golden" trout was developed and popularized in 1963 as "West Virginia's Centennial Golden Trout." The variant arose from a single female, spawned in the fall of 1954, with a body pattern which was a mosaic of those of the "golden" trout and normal rainbow trout (see Clark 1970). This mosaic pattern has been referred to as "chimera." When a chimera female is crossed with a normal male rainbow trout, the light-colored offspring with reduced spotting called "palomino" result. They are heterozygous for a gene causing color dilution. When two "palominos" are mated the progeny consist of normal pattern, palomino pattern, and golden pattern, in a precise ratio (1 normal: 2 palomino: 1 golden).

The presence of these variants in Lake Ontario indicates an extension of range from Lake Erie. The route the fish took is unknown. Their earlier presence in the upper Niagara River would suggest passage over Niagara Falls. The capture at Grimsby might suggest the alternative route through the Welland Canal. The captures in the Ontario Hydro canal suggest that as a possibility. They would have to pass through the power generating equipment but Hydro officials say adult fish can pass and live.

Presently it would appear the source of the variants is the Pennsylvania introductions. There has been, however, notice of 100 000 golden trout produced in Wisconsin by an organization called Salmon Unlimited (Anonymous 1975). If some of these were released in the Great Lakes or tributaries they could contribute to those which might be seen elsewhere in Canada.

The possible ecological effects of the variants on rainbow trout in the lower Great Lakes are unknown.

Major determinants of this effect and of the permanence of the stock of variants are the rate of continued introduction and degree of crossing after release. Since the variants react similarly to the wild rainbow phenotype (R. B. Kenyon, personal communication), spawning of variants with wild normal trout can be expected. According to Wright (1972), if a golden variant crosses with a normal rainbow, palomino trout result. If palomino trout mate with normal rainbows one half of the offspring are palominos and one half normal rainbows. Even if

palominos mate, one quarter of the offspring are normal trout (+ 1/2 palomino and 1/4 golden). Only when palomino trout cross with golden trout (= 1/2 golden and 1/2 palomino) or golden trout cross with golden trout (= all golden) is there no dilution of the variants. There are, therefore, at least two new forms of trout to add to the problem of identification of salmonids in the lower Great Lakes.

The choice of terminology is unfortunate since golden trout is the accepted name for *Salmo aquabonita*, a species native to the western USA and introductions of that species have been attempted elsewhere in Canada.

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Trauma-induced Paralysis in a Moose Calf

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The progressive encroachment of man into wildlife habitats is a profound threat, individually and collectively, for many wildlife species today. We report, as an example, the fracture of a cervical vertebra and consequent paralysis in a free-ranging moose (*Alces alces*).

A live 5- to 6-month-old female moose calf was found lying on its right side adjacent to a three-strand barbed wire fence in the Porcupine Hills of southwestern Alberta; the animal was transported to the laboratory for further clinical examination and necropsy. Clinically the calf was markedly hypersensitive over the anterior thoracic and cervical vertebrae with reduced sensation at the coronary bands of all four limbs. The lids of the right eye were

bruised and there was mild corneal opacity. Rectal temperature was 38.3°C. Blood for hematological examination was drawn by jugular venipuncture into Vacutainer** tubes containing potassium ethylenediaminetetra-acetate. The calf was subsequently killed by an intravenous injection of Lethal.*

At necropsy, the carcass was emaciated, with serous atrophy of fat depots. No gross lesions were observed in thoracic or abdominal organs or in the large arteries of the thorax and neck. The rumen contained a small volume of firm dry forage. A few flakes of fibrin were

**Becton, Dickinson and Company, Canada Ltd., Mississauga, Ontario.

*Haver-Lockhart, Calgary, Alberta.



FIGURE 1. Sagittal section through the axis and C₃, demonstrating the fracture, hemorrhage, and upward displacement of fragments. The atlas has been removed.

present in the right coxofemoral joint; synovial fluid was clear. No gross lesions were detected in the brain. Examination of the vertebral column, however, revealed that the third cervical vertebra was fractured, displaced dorsally, and impinged on the spinal cord (Figure 1). Yellow to brown discoloration of the cord and meninges was marked in this area. Histological examination of the affected spinal cord revealed dorso-ventral compression, severe distortion, and hemorrhage with widespread axonal swelling and extensive softening. Vascular endothelial swelling and proliferation were prominent findings.

Hematological examinations provided the following data: hemoglobin, 14 g/100 ml; leukocytes, 4000/mm³; segmented neutrophils, 46%; lymphocytes, 50%; monocytes, 4%; sedimentation rate, 57 mm/1h and 60 mm/24 h.

Discussion

The loss of forested land because of clearing for agricultural purposes has been identified as a major loss of moose habitat in Alberta (Lynch, G. M. 1974. Moose management plan for Alberta. Alberta Department of Recreation, Parks and Wildlife, Fish and Wildlife Division. Mimeo. 32 pp.). The increasing network of fences in forested areas may be an additional hazard to big-game animals, by altering or occasionally preventing, normal movement patterns of moose and, perhaps elk (*Cervus canadensis*). Moose and elk calves in west central Alberta have been observed caught in fences or separated from the

maternal parent; attacks by farm dogs are often complicating factors (G. M. Lynch, personal communication; W. M. Samuel, personal communication).

R. L. Peterson (1955. North American moose. University of Toronto Press, Toronto. 280 pp.) reported that moose seldom attempt to jump, but when forced to do so, clear obstacles by rearing, placing the front legs over, and then springing or diving over these obstacles with their hind legs. Fences tend to be formidable barriers to calves when their ability to clear obstacles is less well developed than that of mature animals. Circumstantial evidence in this case suggested that the calf had attempted unsuccessfully to jump the fence. The assumption was supported by the proximity of the animal to the fence and by the nature of the injury. By failing to clear the fence effectively, the calf may have fallen heavily on its head, neck, or brisket. The ocular and palpebral lesions, serous atrophy of fat depots, and the presence of dry firm rumen contents indicated that the animal had been recumbent for several days prior to discovery.

The authors thank B. Arnold, Alberta Fish and Wildlife Division, Claresholm, for locating and transporting the moose to the laboratory. J. Wood, V. Wong, and P. Mills of the Veterinary Services Division, Lethbridge, provided much appreciated laboratory technical assistance.

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A Recent Record of the Meadow Jumping Mouse, *Zapus hudsonius*, in the Northwest Territories

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A meadow jumping mouse was captured on 12 August 1975 during field studies in the Northwest Territories. The single specimen (skin and skull) was identified as *Zapus hudsonius* by C. G. van Zyll de Jong, and deposited in the National Museum of Natural Sciences, Ottawa, as NMC 42852.

The animal was collected on the edge of a small thermokarst lake near the northwest end of Chick Lake (65°53' N, 128°12' W; Figure 1), 90 km northwest of Norman Wells, Northwest Territories. Hall and Kelson (1959) and Banfield (1974) considered the northern limit for the jumping mouse in the Northwest Territories to be south of Great Slave Lake and the Mackenzie River. Krapu and Traugher (1972) recorded a specimen near the north shore of Great Slave Lake, 40 km northwest of Yellowknife. (The latitude was incorrectly published as 66°33' N. The correct latitude for their specimen is 62°33' N; Krapu, 1976, personal communication.) The Chick Lake capture extends the known range approximately 360 km.

The vegetation at the present capture site consisted primarily of sedges (*Carex* spp.) and grasses (*Calamagrostis* spp.), with clumps of willow (*Salix* spp.). The forest surrounding the lake was dominated by black spruce (*Picea mariana*) with some white spruce (*P. glauca*) and larch (*Larix laricina*) intermixed. A relatively high degree of thermokarst erosion adjacent

to this small lake was the only apparent feature that distinguished it from others in the area.

The one meadow jumping mouse taken represented less than 0.005% of the total captures in 95 800 trap-nights expended at Chick Lake during the summers of 1973, 1974, and 1975. The most common species trapped were the northern red-backed vole (*Clethrionomys rutilus*) and the meadow vole (*Microtus pennsylvanicus*). Other species trapped at Chick Lake were, in descending order of frequency, chestnut-cheeked vole (*Microtus xanthognathus*), ermine (*Mustela erminea*), red squirrel (*Tamiasciurus hudsonicus*), masked shrew (*Sorex cinereus*), heather vole (*Phenacomys intermedius*) (Douglass and McDonald 1976), arctic shrew (*S. arcticus*; NMC 42840), and pigmy shrew (*Microsorex hoyi*; NMC 42851). Other mammals sighted were varying hare (*Lepus americanus*), muskrat (*Ondatra zibethicus*), marten (*Martes americana*), mink (*Mustela vison*), wolf (*Canis lupus*), black bear (*Ursus americanus*), moose (*Alces alces*), and caribou (*Rangifer tarandus*).

These collections and observations were made during field studies conducted for Canadian Arctic Gas Study Limited by Renewable Resources Consulting Services Limited.

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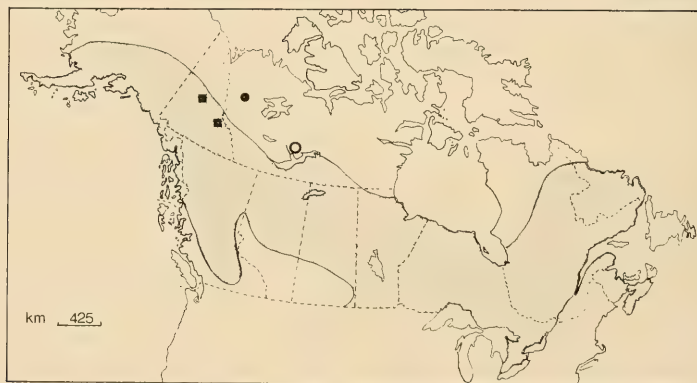


FIGURE 1. Canadian and Alaskan distribution of the meadow jumping mouse, *Zapus hudsonius*, after Hall and Kelson (1959). ● Chick Lake capture, ○ Krapu and Traugher (1972), ■ Youngman (1975).

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Swarming of Dragonflies Noted at Drag Lake, Ontario

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We spent three vacation days at Drag Lake, near Haliburton and Minden, Ontario, 23, 24 and 25 June 1975. A few more than the usual numbers of dragonflies were noted as we approached the lake from the south, but not as thick a swarm as at the lake itself. A specimen of *Cordulia shurtleffi* Scudder was flying about in downtown Minden, crowds and traffic notwithstanding. Roads to Drag Lake were filled with *Libellula julia* Uhler, squatting on bare ground, in both sun and shade.

Drag Lake is situated near Haliburton, Ontario, about 50 km south of the main portion of Algonquin Park, 45.5°N, 78.1°W. The lake is about 1.5 × 6.5 km at its widest and longest points and is said to be as deep as 200 m. During the late nineteenth century extensive lumbering operations consisted of dragging logs across the lake in winter, hence the name Drag Lake. The lake's shores are boulder-strewn and irregular (roughly Y-shaped) in outline; the drop-off appears

steep in most places. Inland are numerous small, shallow bays filled with aquatic vegetation, providing favorable dragonfly breeding habitats.

Weather conditions at Drag Lake on 23 through 25 June were excellent for observing and collecting insects. Day-time temperatures were warm (about 23°C), sunny, with slight-to-moderate wind. Precipitation consisted of a very small amount of rain during the trip up to the lake area, just enough to dampen exposed surfaces.

The dragonfly swarm seemed concentrated at Drag Lake. We explored other areas near and approaching the lake, but found dragonflies much more generally dispersed. The swarm was stationary and was feeding; it consisted of about 10 species of Odonata. Vertical stratification of the swarm was observed (Table 1). Mid-level (1 through 4 metres) was the most active area for both numbers of species and individuals.

The absence of certain common types of dragonfly

TABLE 1—Dragonfly species present, their observed swarming height, and frequency at Drag Lake, Ontario on 23-25 June 1975

Species present	Swarming height			Frequency
	Low (0-1 m)	Mid (1-4 m)	High (> 4 m)	
<i>Cordulia shurtleffi</i> Scudder		x		common
<i>Epiheca cynosura</i> (Say)		x		common
<i>Epiheca princeps</i> Hagen			x	rare
<i>Epiheca spinigera</i> Selys		x		most common
<i>Leucorrhinia frigida</i> Hagen	x			occasional
<i>Leucorrhinia hudsonica</i> (Selys)	x			occasional
<i>Libellula julia</i> Uhler	x			common
<i>Libellula quadrimaculata</i> Linne	x	x		common
<i>Macromia illinoiensis</i> Walsh		x	x	rare
<i>Somatochlora williamsoni</i> Walker		x		rare

behavior within the swarm was interesting to note. Competition in form of territorial aggressiveness and defence and also reproductive activities were not observed. The dragonflies seemed also not as wary of humans as often they are. The mosquito season was in full course; as we walked through the dragonfly swarm at evening the dragonflies came closer to us, flew at lower levels, and fed on the mosquitoes attracted by our presence. Also interesting to note was the scarcity of damselflies at Drag Lake: individuals seen numbered less than 10 or so. It is possible that the large number of dragonflies consumed many damselflies earlier. Mosquitoes, however, appeared the swarm's major target.

As to space and time factors, swarming continued throughout each of the three days, and was heaviest at midday to near sundown. Swarming occurred entirely over land rather than water surfaces.

Some dragonflies were not part of the swarming phenomenon at Drag Lake but were taken as part of our sampling. Along the lake shore were *Gomphus spicatus* Hagen and *Basiaeschna janata* (Say). At one localized and protected cell on the lake's northwest side we found *Aeshna canadensis* Walker clinging to tree branches and trunks at the forest edge, a habitat noted by Walker (1958). *Didymops transversa* (Say) was also taken on vegetation along roadways.

Dragonfly swarming has been studied and noted in the literature. "Swarm-feeding" may be the best term describing our observations at Drag Lake. Corbet (1963) discussed this in some detail. Corbet also commented on the lack of interaction among dragonflies feeding upon other insect swarms. Kormondy (1959) observed six different species of dragonfly flying together in Michigan, with *Epithecina spinigera*

Selys in the majority; this is similar to our observations at Drag Lake. Walker and Corbet (1975) also mentioned *spinigera*'s appearance in numbers in southern Ontario.

None of the dragonflies described here are considered rare for the locality, and may be considered well within their given ranges (Needham and Westfall 1955; Walker 1958; Walker and Corbet 1975).

Acknowledgments

Thanks are given to Miriam Ouellette, proprietress of Drag Lake Resort, for permission to study and collect the dragonflies. Special thanks are also given George Bachmann of the Social Studies Department, Memorial School, Mentor, Ohio, for information on the geography of the Drag Lake region.

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Two Recent Bobcat (*Lynx rufus*) Specimens from Southern Ontario

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As a result of a recent survey of bobcat (*Lynx rufus*¹) material in major Canadian institutions, we found that two specimens of this species in the collec-

tions of the Royal Ontario Museum (ROM) apparently represent the only museum specimens that have been collected in southern Ontario since 1906. One specimen (ROM 25497) is an adult male from Pakenham Township, Lanark County, 1953. The other (ROM 67947) obtained from the Fish and Wildlife Research Branch of the Ministry of Natural Resources, is a young male, found as a road kill on Highway #11, Muskoka Township, Bracebridge District, 1972.

These two specimens are of considerable interest

¹Recently, authors such as van Zyll de Jong (1975) considered *Lynx* as a subgenus of *Felis* rather than a separate genus and assigned the lynx and the bobcat to the genus *Felis*. To avoid confusion with the nomenclature used by Peterson and Downing (1952), Peterson (1966), and Banfield (1974), we used the genus *Lynx* for the bobcat in this paper.

since the racial affinities of the present southern Ontario bobcat population are questionable. Peterson and Downing (1952) assigned the original population to the subspecies *L. r. gigas*, a race that is found also in New Brunswick, Nova Scotia, and possibly southern Quebec (Peterson 1966). But since the only *gigas* material from Ontario available to Peterson and Downing (1952) was collected prior to 1906, these authors suggested that *L. r. gigas* may have become extinct in southern Ontario within the last half-century, and may have been replaced by some other race. According to the distribution map of Peterson and Downing (1952), it is possible that either of two races of *L. rufus* could have recently extended their range into southern Ontario: *L. r. rufus*, found in the eastern United States, or *L. r. superiorenensis* from the northwestern Great Lakes region. Although Banfield (1974) reported that *L. r. rufus* has recently invaded southern Ontario, this conclusion apparently was not based on recent material.

We have compared the skulls of the two recent ROM specimens with those of *gigas*, *rufus*, and *superiorenensis* and when the diagnostic characters described by Peterson and Downing (1952) and Peterson (1966) are used, the skulls appear to conform closely to *L. r. superiorenensis*. Both skulls differ from those of *L. r. rufus* in their dorsal contour and by their relatively smaller third upper premolar (PM³). ROM 25497 could also be distinguished from skulls

of *gigas* by its relatively wider and shorter palate and the ratio of its maxillary tooth row to the width of the palate. Unfortunately, the palatal width of ROM 67947 could not be measured because the skull is partially damaged. The skull of this specimen, however, does conform closely to young male material of *superiorenensis*.

ROM specimen records and reports from trappers indicate that the populations of *L. r. superiorenensis* in Ontario are the result of two recent invasions. Probably derived from the population of *superiorenensis* in Minnesota, this race of bobcat first appeared in Ontario early in the century in the region west of Lake Superior, where it rapidly expanded its range north and east. In the late 1940s, a second invasion occurred when *L. r. superiorenensis* crossed into Ontario from the upper peninsula of Michigan, and by 1952 specimens had been obtained from Sault Ste. Marie (formerly Algoma) District and Cockburn Island, Espanola (formerly Manitoulin) District (Peterson and Downing 1952). Although inconclusive, the identification of the two recent specimens from Lanark County and Bracebridge District as *superiorenensis* suggests that this western race has now spread into southern Ontario (Figure 1). Fur harvest records obtained from the Fish and Wildlife Research Branch, Ministry of Natural Resources for 1973–1975, show that eight bobcats were taken in southern Ontario for this period with specimens trapped in the following southern



FIGURE 1. Locations of two recent bobcat (*Lynx rufus*) specimens from southern Ontario and the distribution of the western race *superiorenensis*. Stippling represents the approximate range of *superiorenensis* in Ontario, each dot represents one or more specimens in the Royal Ontario Museum, and squares represent the two specimens from southern Ontario.

Ministry districts: Lindsay, Cambridge, Tweed, Lanark, Pembroke, and Minden. In order to confirm the taxonomic status of this population of *L. rufus* now inhabiting southern Ontario, the Royal Ontario Museum is attempting to acquire specimens from this region. In a recent study applying numerical taxonomy, van Zyll de Jong (1975) analyzed skull and body ratios of the three subspecies of bobcat discussed in this paper and found that they show intra-specific differences. It would be interesting to compare the present population of *L. rufus* in southern Ontario with these three subspecies using modern taxonomic methods if, and when, an adequate sample size can be obtained.

We thank Bruce Stephenson, Fish and Wildlife Research Branch, Ministry of Natural Resources, for reviewing his bobcat records and providing us with

the Ontario fur harvest records.

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News and Comment

Note to Authors and Referees

For future submissions to *The Canadian Field-Naturalist*, I encourage all authors to suggest potential referees. Although these referees may not be selected to review a particular author's manuscript, they will add to my list from which referees are chosen. This request is now incorporated into the updated Instructions to Contributors.

Editors are constantly searching for experts in particular fields of study to review manuscripts. These experts should base their acceptance or rejection of manuscripts on sound scientific reasoning and on the significance of the contribution to the ever-expanding literature. Authors are always free to rebut the criticisms of referees and editors but their refutations should be based on sound arguments. Referees are particularly requested to keep the average reader in mind when they are evaluating manuscripts. It is important that the research results, and interpretations from them, are communicated in a logical, clear, and interesting manner to the greatest possible number of our readers.

My current editorial policy is to let referees make their own personal choice whether to remain anon-

ymous or whether, by signing their comments for the author, to reveal their identity. From time to time the question of the anonymity of referees is debated (see "Towards open refereeing" by Peter Robertson in the *New Scientist* 71(1014): 410, 1976) and both benefits and disadvantages are recognized. Certainly if a referee reveals his identity, his reputation as well as his relationship with the author is at stake. Editors are particularly grateful that many referees, as a duty to the scientific community, spend a considerable time and effort to perform a service that brings but little reward other than personal satisfaction for a job well done.

All referees should try to show humane consideration for authors (see "A plea for tolerance and courtesy" by David E. Davis in *BioScience* 26(3): 171, 1976). If this is done, then even a negative evaluation, if accompanied by constructive comments and softened by a word of encouragement, can promote good relationships. A working arrangement beneficial to all is our aim.

LORRAINE C. SMITH,
Editor

A New Series on the Biological Flora of Canada in *The Canadian Field-Naturalist*

We feel that the time is right to initiate a series on the *Biological Flora of Canada* wherein ecological life history information for important members of our flora is assembled. Such a series, analogous to, but not identical with, that of the *Journal of Ecology* was

proposed by George H. La Roi and he will be elaborating on the subject in a forthcoming editorial. In order to start the series off on the right foot, it will be necessary to consult with others and to deliberate with care regarding the guidelines and final format.

Environmental Concerns

I draw the attention of our readers to two recent thought-provoking and interrelated editorials: "The impact statement boondoggle" by D. W. Schindler, published in *Science* 192(4239): 509, 1976 and "Where is Canadian environmental science headed?" by D. E. Sergeant, published in the *Canadian Society of Environmental Biologists Newsletter/Bulletin* 33(3): 3-5, 1976.

Dr. Schindler notes that "impact statements seldom receive the hard scrutiny that follows the publication of findings in a reputable journal." Furthermore, he notes that "Having seen the results of many of these impact studies, and evaluated proposals for second-

generation studies, I believe the idea has backfired."

Dr. Sergeant also points out some of the problems in the current government approach to Canadian science—decline in funds for research by government and universities, and an increased reliance on consulting companies. The latter do not publish their research through normal scientific channels and, therefore, many of their reports will eventually be lost.

The views of these concerned scientists should be read by ecologically concerned citizens and hopefully heeded by government policy makers.

LORRAINE C. SMITH,
Editor

Herpetology Information Needed

I am studying the status and ecology of the Blue Racer, Cricket Frog, Island Water Snake (of the Lake Erie Islands), Spiny Softshell Turtle, Queen Snake, and Fowler's Toad in Ontario. The Canadian Amphibian and Reptile Conservation Society, the Ontario Ministry of Natural Resources, and the

Canadian Wildlife Service are also concerned with these animals and have some information about them, but any additional information on their occurrence, habitats, or changes in number would be most helpful. Please send information to Craig Campbell, 421 King Street North, Waterloo, Ontario N2J-3Z4.

Northeastern Regional Meeting of the Animal Behavior Society

Memorial University of Newfoundland will host the 1977 Northeastern Regional Meeting of the Animal Behavior Society in St. John's, Newfoundland. The conference will be held during October at St. Bride's College in St. John's where room and board will be available at reasonable rates.

Papers (15 to 20 min) and poster presentations from all areas of animal behavior are invited. Morning plenary sessions will focus on different groups of marine organisms (invertebrates, fish, birds, and mammals) and will address themselves to three topic areas—navigation, communication-social behavior, and behavioral development. A film session

on marine mammals and a discussion on constraints on learning are also planned. There will be ample opportunity to tour the area.

Registration forms and fees (\$5.00, cheques payable to Animal Behavior Society Meeting) should be submitted by 30 May 1977. Correspondence, requests for registration forms, and inquiries can be directed to Jon Lien, Bill Montevecchi, Cathy Noseworthy, Deane Renouf in the Department of Psychology, or John Green or Jake Rice in the Department of Biology, Memorial University of Newfoundland, St. John's, Newfoundland A1C 5S7.

Third Annual Ontario Ecological Colloquium

This colloquium will be held on 18 and 19 April 1977 at The University of Western Ontario, London, Ontario. It is sponsored by the Departments of Plant Sciences and Zoology.

The organizers hope that as many Ontario ecologists as possible will present papers about their past and present research or initiate discussions on matters of common interest and concern. Tentative session titles are avian ecology; mammalian ecology; fresh-

water fish, reptiles, and amphibians; physiological plant ecology; population dynamics (plant, animal, and microbial); pollution and applied ecology; invertebrate ecology; and community ecology (plant and animal).

For any further information please contact Dr. P. B. Cavers, Department of Plant Sciences, University of Western Ontario, London, Ontario N6A 5B7 or phone 519-679-3282.

The Changing Sea-bird Populations of the North Atlantic

An international conference sponsored by British Ornithologists' Union, British Trust for Ornithology, Royal Society for the Protection of Birds, Seabird Group, Scottish Ornithologists' Club, and the Wildfowl Trust, will be held 26-28 March 1977 at Aberdeen University, Scotland. It will enable many workers on sea-birds in Europe and on the eastern seaboard of North America to meet and find out about each other's research. Members of the sponsoring societies, and others interested in the subject, are also encouraged to attend.

Each day a topic will be covered in the morning by

invited speakers. The afternoon sessions are open to papers on current research, relevant to the general theme of the conference, which may deal with more specific and specialized studies. The morning topics will be human influences, surveys, and population ecology.

Members of the Aberdeen Bird Club are assisting with local arrangements. Booking forms for the conference are available from Dr. Amicia Melland, BOU Office, c/o Zoological Society of London, Regents Park, London NW1 4RY.

Book Reviews

ZOOLOGY

Handbook of Common New Guinea Frogs

By J. I. Menzies. 1976. Wau Ecology Institute, Wau, New Guinea. Wau Ecology Institute Handbook Number 1. 75 pp., illus. \$3.20.

The large island of New Guinea has a rich and varied fauna, with over two hundred species of native frogs, some of these, however, being represented by a single or few specimens. Much more remains to be done; and undoubtedly other new species will be discovered. Dr. Menzies has chosen fifty common species, and these are described and illustrated in color in his new work.

The text is broken down as follows: Introduction; A note on frog biology; The colors of frogs; The frog fauna of New Guinea—composition and origin; Further reading; A guide to the identification of frogs on the New Guinea mainland. This takes up about 16 pages. The Systematic account, which is the main body of the text, comprises some 45 pages. This is followed by a 1-page section on the preservation of frogs, a 2-page Glossary, and an important 6-page Appendix that lists the species of frogs that have been described from Papuan subregion. Dr. Menzies does

not (very wisely perhaps) make comment on the validity of the names mentioned in the Appendix. There is also a 2-page Index.

Descriptions of the fifty species (or occasionally a species group) are of necessity brief, but should be adequate in most cases. Included in each description are also notes on variation and habitat. The color illustrations for the most part can be described as very good.

For anyone interested in New Guinea frogs this work should be as useful in the library as in the field. Considering the extremely modest cost of the book one cannot possibly go wrong in purchasing a copy. Dr. Menzies is to be congratulated. It is hoped that other handbooks, now in preparation, on the flora and fauna of New Guinea, will measure up to Handbook Number 1.

STANLEY W. GORHAM

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Waterfowl of North America

By Paul A. Johnsgard. 1975. Indiana University Press, Bloomington. 575 pp. \$25.

The stated purpose of this book is to provide an up-to-date account of the ecology and reproductive biology of all species of waterfowl in North America. It was with pleasure that I received it; no major work of this kind had been produced since F. H. Kortright's (1942) "Ducks, Geese and Swans of North America." With the tremendous volume of data which has accumulated since 1942, an updated modernization of this classic work combining breeding distributions, life cycle and behavioral observations was overdue. Dr. Johnsgard has attempted to reach a large audience including naturalists, hunters, and professional biologists. This is an extremely difficult goal, and one which he has only partially attained.

The introductory chapters present a useful and lucid discussion of present-day theories on the ecology of waterfowl. Interesting parallels are shown between North American and Eurasian species. Some of the material presented, however, is too simplistic to be of value. For instance, the author rightly recognizes the

problems of generalizing with respect to habitats used by species of waterfowl, and then presents a summary table of habitats with its obvious drawbacks. (Not all Snow Geese nest on coastal deltas; the Banks Island colony is more than 20 km inland. Whistling Swans and Ross' Geese are not considered high arctic breeding species and Pintails are more abundant in prairie and parkland habitats than in low arctic areas.) Many of the data presented in the tables are out of date. In some cases they are meant only to indicate trends, but kill data, Christmas counts, and monetary values are obsolete. Within these chapters a section relating particular problems facing waterfowl would have been timely and meaningful. In particular, oil pollution as it relates to arctic species and wintering populations could have been mentioned.

The body of the book comprises individual species accounts including physical parameters, guides to identification, age and sex criteria, breeding and wintering distributions, biological, ecological and behavioral data. Missing is information on migration routes, important staging areas, and times of year

when the various species are to be seen in different areas of the continent.

Within the species accounts, many of the data are well-presented, particularly the summarized information on behavior. But many factual errors exist among the data on breeding distributions and incomplete discussions of habitats are presented. Examples of errors include a misquotation of Manning et al. (1956), who do not state that Ross' Geese breed on Banks Island; Snow Geese do not breed throughout Banks Island but are confined to the southwest (Manning et al. 1956); both Atlantic Brant and Pacific Brant are known to nest on Prince Patrick Island (Handley 1950); MacDonald (1960) and Godfrey (1966) report that brant breed on Ellef Ringnes Island; Gadwalls and Lesser Scaup breed in Quebec at Lake St. Francis (Ouellet 1970); no breeding records exist for Pintails on Banks Island (Manning et al. 1956; Godfrey 1966); and the range map presented for the Red-breasted Merganser is incorrect relative to evidence presented by Godfrey (1966). Most of these errors stem from an apparent incomplete review of Canadian literature on waterfowl, especially from the high Arctic, Mackenzie Valley, and Hudson Bay/James Bay.

Breeding habitats should have been dealt with in a more complete manner, specifically in the case of cosmopolitan species. No mention is made of nesting habitats of Mallard, Black Duck, Pintail, American Wigeon, or other species in boreal forest areas.

In addition to factual errors, editorial mistakes are also prevalent. The range maps inaccurately portray the Queen Elizabeth Islands; Manning et al. (1956) is noted as 1958 in the bibliography; and C. J. Lensink's name is misspelled on page 87, to illustrate a few.

This book is of value to persons who are unfamiliar with waterfowl or the published literature. But because of incorrect and incomplete data this work has not fulfilled the stated objectives and as a result does not present a true picture of the waterfowl of North America.

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Handbook of North American Birds. Volumes 2 and 3. Waterfowl, Parts 1 and 2

Edited by Ralph S. Palmer. 1976. Yale University Press, New Haven, Connecticut. 521 and 560 pp. \$30 each.

Waterfowl enthusiasts who collect books about their subject have long been plentiful and have been given much to collect. Now, in less than a year, those in North America have been presented with four large new volumes, by Paul Johnsgard, by Frank Bellrose and, most recently, these two stately compendia by Ralph Palmer and a team of thirty-two collaborators, including most of the best-known names in the business (about a third of them Canadian). It has taken Dr. Palmer fourteen years of hard labor and he has been triumphantly successful, particularly as some of his colleagues are almost as well known for their reluctance to write as for their knowledge of this goose or that duck.

This is, happily, a book for ornithologists, rather than for duck hunters or 'waterfowl managers.' "The main purpose of these volumes is to present accounts of species": thirty-five in Part 1 (whistling ducks,

swans, geese, and dabbling ducks) and twenty-nine in Part 2 (diving- and sea-ducks, mergansers, wood ducks). The taxonomy is that of a conservative 'lumper,' i.e., mostly after that of Delacour's *Waterfowl of the World* (1954-1959) trying yet again to treat the Brant as a single species, the Blue Goose as a color phase of the Snow Goose (in *Anser*), and describing the Canada Goose by as few as eight trinomials. Eighteen of the species accounts are brief, because the birds described are not now native to North America, including the sad case of the Labrador Duck, which became extinct a century ago before much was learned about it, but these short treatments of other people's birds keep up the high standard of the major essays, although sometimes not fully updated since first being written a decade or more ago.

One of the major features of this handbook, not to be found in any recent competitor, is the very full description of all known plumages ("what the bird is

wearing"). As an elderly European, reared on Schiøler and Annie Meinertzhagen, I find the plumage-naming awkward, but suppose that this work will help to consolidate the use of the system introduced by Humphrey and Parkes (1959, Auk 76: 1-31). The colored figures of downy young, done originally direct from life, by Colleen H. Nelson are worthy of a book by themselves. The sections on field identification are full of acute observations. The treatments of distribution and migration do an effective job of boiling down what is often a welter of conflicting facts and awkward gaps into a semblance of coherence. The sections on banding status, most often little more than a record of numbers marked and recovered up to some date long past, could have been left out. The breeding biology and habits sections include many major essays and much information previously unpublished, buried in theses or agency reports or the heads of biologists. It is this "new" knowledge above all that

will make these volumes useful and enjoyable for many readers; and that will also, one hopes, prompt further studies. Although Palmer writes of the Anatidae as "already the best-known avian family" he reminds us repeatedly, if implicitly, how far we are away from an adequate view of waterfowl and their place in nature. Those of us who care for birds, even if only ducks, have many reasons to applaud the work of Palmer and his team. We have no good cause to reproach them either, though it is sad that to save space the Literature Cited section (still 27 pages in length) omits the titles of papers and gives only meagre details of books. From Abdulali (1949) to Ytreberg (1960) is a long journey. We salute the travellers; with Ralph Palmer in the van.

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Insects that Feed on Trees and Shrubs: An illustrated practical guide

By Warren T. Johnson, and Howard H. Lyon, with the collaboration of C. S. Koehler, N. E. Johnson, and J. A. Weidhaas. Cornell University Press, Ithaca, New York. 464 pp. \$35.

The striking feature of this invaluable book is the series of 212 color plates, comprising about 1500 individual photographs, of which all but 13 were taken by the authors and collaborators. The photographs depict over 700 species of pests, mostly in the living state, and their work. Explanatory text, sometimes accompanied by monochrome figures, is given on the facing pages. The illustrations are not only technically and artistically excellent, but they are carefully chosen to help forester, landscaper, and gardener to recognize the pest and the damage it causes as he is most likely to encounter them. The text gives brief but useful notes on the biology and importance of each pest and often of similar species on the same or other hosts. A wide range of trees and shrub species is represented, and both eastern and western parts of the continent are dealt with.

The organization of the book is logical, though the diversity of subject matter makes it a little hard to find one's way through it. There is a main division between conifer-feeders and feeders on broad-leaved plants. Within each grouping there is a secondary classification, partly by type of damage and partly taxonomic, and within these categories a tertiary subdivision, again partly biological and partly taxonomic. A "Reader's Aid" at the beginning gives a

bird's-eye view of this arrangement, and more detailed access is provided by the very comprehensive index.

In general the emphasis is on forest and shade trees and ornamental shrubs, though there are frequent references to fruit-tree species. It would be easy to complain of pest species that are omitted: almost every reader would have his own list of neglected favorites. Actually the selection of species is very good, particularly when it is considered that it depended on the available photographic material. Though frequently suggested, the great variety of unmentioned pests probably deserves more emphasis. Occasionally there are misleading statements in this regard, as on p. 166, "...larvae of several species of moths mine oak leaves" [there are dozens]. "There are two common species in the eastern states" [there are many]. As might be expected with so wide a coverage, there are taxonomic inaccuracies (mostly not serious), e.g., *Dioryctria abietivorella* Grote is listed under the old identification *D. abietella* (D. & S.) on p. 24. There are some misprints, e.g., on p. 222 *Euzophera semifuneralis* is given as *semifumeralis*. The treatment of authors' names for species is erratic: they are abbreviated or not, often on the same page—Walsingham and Wlshm. on p. 36; periods are often omitted after abbreviations—Keif for Keifer on the same page; diacritical marks and accents are at least sometimes omitted from foreign names, and, though parentheses are generally used for authors' names where appropriate, they are often omitted.

There is an extensive list of references. Unfortunately the selection is rather haphazard, and the best sources are not always cited. Dominick et al., *The Moths of America North of Mexico*, is not even mentioned; only one of the numerous publications by W. R. Richards on aphids and scales is listed; Chapman and Lienk on the tortricid fauna of apple in New York, Stehr and Cook on North American tent caterpillars, Freeman et al. and Morris et al. on the spruce budworm and allies, and many other key references are omitted.

Probably wisely, no effort has been made to give control recommendations for the various pests. Technology changes too rapidly and control measures differ too much in different environments and geographical areas for such recommendations to be appropriate in a reference work of lasting value such

as this one. Instead the reader is advised to consult government and other information sources in his locality, and there is a useful section of such sources and how to get in touch with the agencies.

Even after many years as a professional entomologist and very amateur horticulturist, I found this book a revelation. It supplements in a vivid and highly informative way the standard taxonomic, agricultural, forestry, and horticultural manuals previously available. The authors are to be congratulated on a thoroughly successful achievement.

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The Behaviour of Ungulates in Relation to Management

Edited by V. Geist and F. Walther. 1974. IUCN Publications, New Series No. 24. Morges, Switzerland. 2 Volumes. 941 pp. \$15.

The Behaviour of Ungulates in Relation to Management is a collection of papers presented at an international symposium held at the University of Calgary, Alberta (2–5 November 1971). Contained in the two-volume text are 55 presented papers and one summary paper. The convenors had decided "that our diverse objectives could best be realized by asking senior workers to concentrate on syntheses, and by requesting those who had recently finished major field studies to report directly on their work." Of particular interest at the symposium were papers dealing with "the relationship of ecology to social behaviour." It would appear, however, that not all papers presented at the symposium were included. For example, reference to a presentation by A. B. Bubenik, noted in the Proceedings of the first international Reindeer and Caribou Symposium held in Alaska (9–11 August 1972), on "social well being as a special aspect of animal sociology," appears to have been omitted.

Although the conference was held in North America, only 50% of the contributors resided on this continent. The species examined, the study areas utilized, and the researchers themselves all attest to the truly international scope of this symposium. Canadians made an admirable showing either authoring or co-authoring 12 papers.

Among the general review topics in Volume One are mother-infant relationships, combat and courtship displays, and scent communication. Other papers examine specific ungulate groups such as the Equidae,

the Suidae, and the African Bovidae.

Volume Two presents information on the specific application of ethology to management. For instance, Laws' paper on elephants points out the social function of the old females within elephant populations. These individuals assume the leadership and infant-care responsibilities. Were these animals indiscriminately removed from the elephant population the herd's survival would be seriously damaged. A different viewpoint is suggested by Cumming in his report on roe deer. Apparently mock fighting among young non-territorial bucks accounts for most of the tree-bark destruction caused by roe deer. The tree damage could be reduced by removing some of these young bucks without threatening the population's ultimate survival. Another interesting example of management by utilizing 'characteristic behavioral traits' is Wilkinson's description of techniques used in capturing young muskox for domestication purposes.

The papers of this symposium clearly show the importance of ethology to management. Since world ungulate species represent valuable recreational resources and, in some cases, have significant potential as protein sources for human consumption, increased ungulate production ought to be a serious management objective. Utilization of behavioral characteristics in management practices may help meet this objective. This book may help many managers and should be read.

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Mammals of the World

By E. P. Walker. 1975. Third edition. Edited by J. L. Paradiso. Johns Hopkins University Press, Baltimore and London. 1500 pp. \$43 for the two boxed volumes.

Mammals of the World, begun by Ernest P. Walker in 1933 and first published in 1964, has proven so popular that it has recently appeared in a third edition. For those who do not know this work, it is a two-volume, attractively boxed, 1500-page compendium of much that is known about Recent mammals with at least one page devoted to each order, one to each family, and one to each genus. Species are often discussed specifically under genus. The text deals with such information as distribution, habitat, coloration, anatomical details, reproduction, and habits.

Compared to the original volumes which have the same pagination, this 1975 edition has few changes in the text, even for mammals on which research has recently been carried out. There is no new information, for example on moose, beaver, narwhal, or Canadian deer. Apparently only if information was sent in to the Genera of Recent Mammals of the World project, sponsored latterly by the New York Zoological Society, as I sent some on the giraffe, was it incorporated into this new edition which was supervised by John L. Paradiso after the death of Walker in 1969. In the first edition a third volume contained references to research works on mammals on which the text was based. This volume has wisely been

omitted by Paradiso. References are soon outdated and can readily be retrieved from other sources such as *Biological Abstracts* and *Zoological Records*.

One way in which this edition is superior to its predecessors is in its pictures, all black and white, which occur on almost every page. Where in the first edition there were many blank spaces, these are now often filled with photographs. For example, there are two new photos of the mule deer, while those of the pronghorn and moose have been exchanged for better pictures. Where possible, drawings have been replaced by pictures of living animals, and there are fewer photographs of museum study skins and mounted ones to represent little-known species. Where taxonomically useful, photographs of skulls are presented.

This edition of *Mammals of the World* contains a few anomalies. For example, why has the African tree rat of 1964, *Colomys goslingi*, become the African water rat of 1975?

This work should be essential for every university library and for other professional libraries that have a zoological bias. The price, which I am sure is justified, will unfortunately prohibit many zoologists from buying it.

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BOTANY

Catkin Bearing Plants (Amentiferae) of British Columbia

By T. Christopher Brayshaw. 1976. British Columbia Provincial Museum, Occasional Paper Number 18. British Columbia Provincial Museum, Victoria. \$3.00.

This book is the latest in a series of contributions to the Flora of British Columbia published by the British Columbia Provincial Museum.

Dr. Brayshaw covers in his treatment the genera *Populus*, *Salix*, *Myrica*, *Alnus*, *Betula*, *Corylus*, and *Quercus* which are included in four families. Only two of these genera, *Salix* and *Betula*, contain a substantial number of species and *Salix* dominates the book with 43 species. The "Amentiferae," as the author recognizes, is not a natural group of families, but evidently they are dealt with here as a group in order to include these important families of deciduous trees and shrubs under a single cover. *Salix* and *Betula* are taxonomically very difficult plant genera and the

author is to be commended for his efforts to make these plants more understandable to serious amateurs, wildlife biologists and botanists alike.

The outstanding feature of this work is the excellent pen-and-ink illustrations done by the author himself. They are of high professional and artistic quality and aid in the recognition of the species in a way that few illustrations do. The only shortcoming of the illustrations is that the technique does not enable leaf pubescence to be well displayed and *Salix exigua* ssp. *exigua* and *S. commutata* do not come across as the hairy plants that they are. Also it seems that the illustration of *S. exigua* ssp. *melanopsis* (Figure 22) was based on a misidentification of a specimen of ssp. *interior* with blunt bracts.

In addition to the illustrations, detailed distribution maps are presented for each species. These maps very

well illustrate not only the distribution of the species in the province but also the large gaps in our knowledge of the flora of British Columbia. Hopefully this book will challenge collectors to collect these genera with more confidence and to learn more about these interesting plants.

In some species the infraspecific taxa have been mapped using different symbols. It would have been useful if this technique had been used more often. Even in those species whose subspecies and varieties do not show any geographical distinctiveness it would be useful to make that point. In *Salix barrattiana* the author recognizes var. *tweedyi*. It would be helpful to know where this variety occurs in British Columbia, since, as far as I am aware, it does not occur in Canada.

In the text each species is treated separately and a concise but adequate description is followed by brief ecological and distributional notes. Where infraspecific taxa are recognized a key is presented and sometimes these taxa are discussed. In his recognition of infraspecific taxa in *Salix* the author seems to have accepted, or at least included, as many names as he could find. It is hard to conceive that he could have seriously studied the variation of these plants, either in the herbarium or field, and then proceeded to recognize the many varieties and forms that have been based on single characters such as leaf shape or pubescence. For example, the narrow- and broad-leaved variants of *S. barrattiana*, and *S. planifolia*; the hairy- and glabrous-leaved variants of *S. bebbiana* and *S. sitchensis*; and the capsule-pubescence variants of *S. gracilis* are all given formal recognition. From the point of view of a wildlife biologist or amateur botanist the use of formal nomenclature for these trivial variations must seem to complicate the matter unnecessarily. This information could have been better conveyed in a paragraph dealing with morphological variation in the species. Furthermore, the use of var. *hypoglaucæ* of *S. pedicellaris* is difficult to justify in light of the evidence that the absence of wax on the undersurface of the leaves of the type collection is almost certainly an artifact of drying.

It is generally accepted in taxonomic works for the description to be based mainly on dry herbarium specimens. Sometimes, however, this may result in misleading information for the field biologist. During a collecting trip on Vancouver Island, on which I was accompanied by the author, we tried to locate specimens of *Salix geyeriana*. We eventually found plants that appeared to be this species on the margins of a small lake; but the twigs were yellowish-green rather than blackish as is usually described in the literature. We discovered later that the twigs are always yellowish-green to greenish-brown in life but become black on drying. I am surprised, in view of the

confusion that this point caused us, that Dr. Brayshaw did not attempt to clarify this for other field biologists.

In most of the genera treated here, especially *Populus*, *Betula*, and *Salix*, hybridization is relatively common and does pose serious problems in identification of individual specimens. The author discusses the nature of hybridization and mentions that this may lead to some confusion in identification but he loses the opportunity to describe the importance of hybridization in nature and the means whereby the hybridizing species remain distinct in the face of hybrid swarms that theoretically could lead to their complete merger. In some cases I experienced some uncertainty about the author's understanding of particular hybrids. *Betula papyrifera* var. *subcordata* is treated by the author as a variety but in the discussion he mentions that Dugle has shown it, "to be an introgressant resulting from crossing of *B. papyrifera* with *B. occidentalis*." If he is of the opinion that Dugle is incorrect, and that is implied by his taxonomic treatment, then he should have clearly expressed his position and reasons.

In the author's attempts to publish new taxonomic combinations or to change the taxonomic status of existing names the correct procedure according to International Rules of Botanical Nomenclature, was not followed, except in one case, and the proposed name changes are therefore not validly published. These errors are undoubtedly an oversight on the part of the author and it is regrettable that such lapses, that could have been caught by an external reviewer or a knowledgeable editor, mar an otherwise creditable work.

I do not wish to dwell on the negative aspects of this book, for much credit should go to the author for tackling a very difficult group of plants. The preparation of keys to *Salix* and *Betula* is a very difficult task indeed and the examination and identification of the many specimens and the plotting of their distribution is very time-consuming. The inclusion of taxa that are not known from the province, but to be expected there was a good bit of foresight and one of these species, *Salix setchelliana*, was discovered by the author even before the book went to press.

There is no question that all naturalists interested in the flora of British Columbia should own this book. If it leads them, as I think it will, to a greater awareness of these important plants and helps them overcome their fears of the taxonomic problems that they present, then this work will have been more than justified.

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Atlas of United States Trees. Volume 2. Alaska Trees and Common Shrubs

By Leslie A. Viereck and Elbert L. Little. 1975. Miscellaneous Publication Number 1293, Forest Service, United States Department of Agriculture, Washington, D.C. Text 19 pp. + 105 full-page maps. Paper \$3.10.

This publication represents the second volume of a projected series entitled the *Atlas of United States trees*. The stated objective of the series is to present atlases of large-scale maps which clearly summarize the known natural distributions of native trees and shrubs. The publication of such species distribution maps has considerable value (1) in serving as a basis for many kinds of phytogeographical and related systematic or evolutionary studies, (2) for indicating to botanists where possible errors or gaps in distributional knowledge may exist, (3) in preserving for historical records the original natural distributional information before possible destruction or alteration of the natural vegetation by human activities, and (4) in serving such economic purposes as indicating where valuable species or possible ecotypes might be located. The authors also stress the potential value of the maps for land-use planning.

Volume 1 of this series presented large-scale distribution maps of 200 conifers and 106 of the more important hardwood-tree species of the contiguous 48 states. Volume 2 contains Alaskan distribution maps (all 12×11 " size at the scale 1:10 000) of 82 species of native woody plants including 32 trees and 50 shrubs, six of which sometimes reach tree size. Since this number includes all trees but represents hardly one half of the total number of native shrub species in Alaska, a choice was apparently made to include only the larger, more common, more widely distributed, and economically or ecologically more important shrubs. One wonders at the omission of some relatively common, or at least locally abundant, shrubs, such as numerous species of *Salix*, *Betula occidentalis*, *Arctostaphylos alpina* (including *A. rubra*), *Diapensia lapponica*, *Rhododendron camtschaticum*, *Cassiope* spp. (particularly *C. tetragona*), *Dryas* spp., *Phyllodoce* spp., *Loiseleuria procumbens*, *Linnaea borealis*, etc., especially when other shrubs, either just as limited in distribution, or equally as low-growing in habit, as some of these, were included. This is not intended as a serious criticism, however; the reader should note only that this volume does not constitute a complete atlas compendium of all Alaskan shrubs.

Plant taxonomists will not necessarily agree with all of the authors' concepts and treatments of the species of particular groups. In most cases, I would agree with them, although it does seem unfortunate to me that all of the tree birches have been lumped together and mapped as a single taxon, *Betula*

papyrifera. The authors' taxonomic treatment as well as their mapping of species distributions of the difficult willow genus, *Salix*, is taken almost directly from Argus (*The Genus Salix in Alaska and Yukon*, National Museum of Canada, Publications in Botany, Number 2, 1973), although hardly more than one third of the species recognized by the latter for Alaska are included in the present volume.

Volume 2 of this Atlas essentially follows the format of Volume 1, but it differs in several noteworthy respects. The county outline type of base map, which was used in Volume 1 for showing species' ranges in the 48 contiguous states, is replaced by a base map of Alaska which is essentially hydrographic, showing rivers and lakes, on which dots or rings are superimposed to indicate the location of cities, towns, and other key places. Preceding the 82 individual species distribution maps that represent the primary objective of this volume, are 23 large-scaled general maps, showing numerous physiographic, environmental, vegetational, geo-historical, political, etc., features, which are useful for a better understanding of the species' distributions and for allowing possible correlations to be made in their interpretation. The bringing together of all this geographical and especially environmental information about Alaska in these general maps should be considered one of the more valuable contributions of this publication. Nevertheless the convenient transparent overlay maps by which such environmental etc. features were presented in Volume 1 may be missed by some readers.

Unlike the maps in Volume 1, the species distributions are not indicated by a black cross-hatching or gray shading of the overall ranges, but rather by dots each representing a known distributional record. The presumed overall range limits are then shown by lines drawn conservatively around the dots. The use of such dot distribution maps seems much preferable to shading simply the overall ranges, since possibly unusual "extraterritorial" occurrences are not over-emphasized. All distributional information is given in a red-brown colour and thus is clearly set off from the clutter of the black on white base-map features.

The species ranges have not been mapped outside of Alaska. The text, however, contains a brief paragraph for each included species which summarizes both the Alaskan and extralimital ranges. For more ample species descriptions, botanical drawings, and ecological information, the reader is referred to Viereck and Little (*Alaska trees and shrubs*, Agriculture Handbook Number 410, Forest Service, United States Department of Agriculture, Washington, D.C., 1972, \$3.25).

The species maps show known presence or absence, but not abundance or density; thus, these maps are not meant to indicate forest cover or vegetational types. This is an important distinction which would seem to undermine somewhat the authors' repeated contention that these distribution maps should serve as a valuable basis for land-use planning. As in Volume 1 of this atlas series, an attempt has been made to record only the known, presumably natural occurrence of each species, but not to explain or speculate on how or why it occurs where it does; such interpretations are left for other phytogeographers to make using the information made available here.

The users of atlases such as Volumes 1 and 2 of the present series will be concerned about the reliability of the maps. The species maps of Volume 2 may well be more reliable, although likely less complete, than those of Volume 1, largely because they have been compiled from fewer and these quite reliable literature sources, which have then been amplified by herbarium specimens mostly seen by the authors and sight records that are also mostly those of the authors themselves. The primary original basis for most of

these species distribution maps appears to have been Hult n (*Flora of Alaska and neighboring territories*, Stanford University Press, California, 1968), or in the case of *Salix* species, Argus (1973). The locality records for the species maps might well have been considerably amplified, although perhaps not significantly enough to change many range limit lines, if the authors had checked more specimens available in various unconsulted herbaria which contain sizable Alaskan collections.

This volume is recommended to anyone who has an interest in the distribution of native trees and shrubs of Alaska and adjacent Canada. It would seem especially useful for botanists (systematists, ecologists, phytogeographers, evolutionists, etc.), foresters, and naturalists if used in conjunction with the 1972 book, *Alaska trees and shrubs* by the same authors.

VERNON L. HARMS

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ENVIRONMENT

Ecological Sites in Northern Canada

Edited by David N. Nettleship and Pauline A. Smith. 1975. Canadian Committee for the International Biological Programme Conservation Terrestrial—Panel 9. Canadian Wildlife Service, Ottawa. 330 pp. Paper \$3.75.

There are areas in northern Canada of biological, geological, and historic importance which urgently require special attention. The scope and intensity of human activity is expanding rapidly in Canada's north and pristine wilderness areas are now threatened. This is the subject matter of the publication.

In 1968, the Canadian Committee for the International Biological Programme (IBP) designated panels for 10 geographical regions in Canada. Panel 9, Arctic tundra areas, and Panel 10, Subarctic areas, fall within the Yukon and Northwest Territories. Panel 9 sites are described in this publication.

The objectives of the northern panels were these:

(1) to locate and describe representative examples of natural arctic and subarctic ecosystems in cooperation with local residents, industry, and the Federal, Northwest, and Yukon Territorial Governments;

(2) to demonstrate how the biological values of each potential site may equal or outweigh all other values of that site; and

(3) to aid the three governments in providing for the preservation of these biologically important areas in the form of Ecological Sites.

Ecological Sites are designated special areas encompassing a variety of plant and animal communities. Many of these communities contain relict or endangered populations, unique plant associations, breeding areas, and critical habitat for wildlife.

All interested parties cooperated to ensure that the traditional hunting and fishing privileges of indigenous people were protected. Also, necessary and realistic consideration was given to gas, mineral, and oil development activities. Many proposed sites can support multiple land use, while other sites of high biological value may be too sensitive to disturbance.

Panel 9 is divided into seven geographical regions. A total of 71 proposed sites is discussed in the publication. Each site is identified by geographical name, plus latitude and longitude.

Each entry is accompanied by a map of an appropriate scale. Geographical and topographical features of each site are discussed, plus exceptional features such as bird, mammal, and marine populations, migration routes, critical wildlife habitat, vegetative patterns, archeological sites, etc.

The extensive bibliographic references relating to each site are perhaps the most valuable aspect of this volume. Literally hundreds of bibliographic entries are listed and enthusiastic northern students can derive immense knowledge by pursuing these references.

One important aspect of each entry is an indication of the protective status. Of the 71 sites discussed, only 12 receive some form of official protection as portions of Migratory Bird Sanctuaries, Game Sanctuaries, or National Parks. Therefore, the casual reader must not infer that the sites listed are "saved," as it were. These sites are proposals only and will be subject to review before receiving official IBP status.

The reviewer has been fortunate enough to have viewed several of these areas personally. Areas such as

Padle-Kingnait Fiord, Baffin Island; Cape Searle, Baffin Island; Anderson River, Region 4 and Caribou Hills, Mackenzie River Delta are all worthy of IBP status with high biological and aesthetic value.

This book contains very worthwhile information for developers, development-oriented agencies, and northern planners in general. The bibliographic references are a real plus and make the book a valuable tool for anyone interested in northern conservation, ecology, geology, and archeology. This volume belongs on any Arctic reference bookshelf.

DAN MURPHY

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Environmental Change in the Maritimes

Edited by J. G. Ogden, III and M. J. Harvey. 1975. Nova Scotian Institute of Science, Halifax, 109 pp. \$5.00.

This little book, published as a supplement to the proceedings of the institute, is the result of a symposium in Quaternary history held at Dalhousie University in 1971. Change began, for purposes of the symposium, as melting glacial ice began to uncover Nova Scotia and New Brunswick about 13 000 years ago. The environment, studied largely for its own sake, is presumably defined as the human environment. It is the geography of land and sea, of the vegetation and fauna, terrestrial and marine. Change in the physical environment of organisms, change in their distribution through ecology and migration, are both studied, and change in the human habitat, reflecting in part man's impact on nature, is studied for the prehistoric and recent past.

The writing varies as in most symposia from the quite simple and popular to that which makes few concessions to the non-scientist. All have made an effort to adjust to general communication, simplifying with maps and tables, if not in the language. It is a praiseworthy attempt to set forth at an early date the results of recent work on geology and biology of the Maritime Quaternary. But, although one contributor has made an effort to update his bibliography, it is regrettable that four years should have elapsed between symposium and publication.

Ogden introduces the symposium with the idea that quite a small change in such large systems as climate may bring about major change in biology. Even glaciation may be a "small change" amplified. But Terasmae details sixteen categories of hypotheses of climatic change; evidently, it is not to be explained

simply. He uses the Bryson-Borchert hypothesis of the correspondence of vegetation zones with the dominance by a particular combination of winter and summer air masses, to emphasize the relationship of vegetation and climate and to pose the general questions.

Railton and Mott report on postglacial vegetation change as exhibited by pollen sequences, the former from Nova Scotia, the latter from New Brunswick. The only symmetrical arrangement of radiocarbon dates suggests to the former a local ice-cap centered about Kejimikujik National Park and persistent till nearly 7620 BP. The latter finds retreat of the ice margin across New Brunswick extremely rapid. In Railton's article, many divergences in interpretation between his findings and Livingstone's are emphasized. The pollen record is not as yet fully harmonized.

Faunistic studies show an important effect on littoral shellfish (Bousfield and Thomas) of changes in sea temperature, and strong effects on the distribution of beetles—and, by extension, other insects?—from human economic activity (Howden). Byers shows the effects of prehistoric man on fauna: Pleistocene overkill is more likely a result of indifference and omnivory than of overspecialization on a favorite game (mastodon). Fire, he suggests, was introduced into this susceptible forest rather to modify habitat for moose hunting than for its very limited agriculture. Mann illustrates the impact of recent economic demands on the environment in referring to the endangering of the Atlantic salmon population and the pollution of Maritime shores. Perhaps our comfort as to the future must be sought in such technological feats as now maintain salmon on the St. John River above Mactaquac Dam.

Grant reviews the evidence as to rates of coastal submergence, its location and causes, thus providing a most interesting supplement to Goldthwait's classic of 1924, *The Physiography of Nova Scotia*. In conclusion, Ogden suggests the value of certain isotopes as measures of change, such as pollution, in the environment.

Has the Quaternary in general not seen rapid change in the biota of the Maritimes and its environment? Should man's activities be looked upon as a mere fluctuation in the geological record, another

change among many? Since the ice began to melt away, man seems to have induced a series of ever more rapid changes. May not change in the freshwater and coastal environments be as great as the changes brought about in flora, insect, and other terrestrial faunas over the past two centuries?

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NEW TITLES

Zoology

Advances in the study of behavior. Edited by J. S. Rosenblatt, R. A. Hinde, E. Shaw, and C. Beer. Volume 6. Academic, New York. 304 pp. \$19.50.

† **America's master of bee culture.** The life of L. L. Langstroth. 1976. By Florence Naile. Cornell University Press, Ithaca, N.Y. 215 pp. \$9.95.

Amphibians and reptiles of the Lake Michigan Drainage Basin. 1976. By Edwin D. Pentecost and Richard C. Vogt. Volume 16, Environmental status of Lake Michigan region. Argonne National Laboratory, Argonne, Ill. (Order from U.S. National Technical Information Service, Springfield, Va.) 69 pp. Paper \$4.50.

* **Anatomy of fishes, part I: text and part II: figures and plates.** 1976. By Wilhelm Harder. Translated by Stephen Sokoloff. 2nd edition. Schweizerbart'sche, Stuttgart. xii+ 612 pp. and ii+ 132 pp., illus. DM 238 (\$96.40).

Animal communication by pheromones. 1976. By H. H. Shorey. Academic, New York. 176 pp. \$16.50.

Aspects of sponge biology. 1976. Edited by F. W. Harrison and R. R. Cowden. Academic, New York. 371 pp. \$16.50.

† **Biology of the Kaministiquia population of barren-ground caribou.** Part 4: Growth reproduction and energy reserves. 1976. By T. C. Dauphiné, Jr. Canadian Wildlife Service, Ottawa. Report Series No. 38. 69 pp., illus. Paper \$3.25 in Canada, \$3.90 elsewhere.

† **Bird hazards to aircraft.** 1976. By H. Blokpoel. Clarke Irwin, Toronto. xiv + 236 pp., illus. \$9.50.

Bird sounds. 1976. By Gerhard A. Thielcke. Translated from German edition (1970). University of Michigan Press, Ann Arbor. viii + 190 pp., illus. Cloth \$6.95; paper \$2.95.

† **The birds of New Brunswick.** 1976. By W. Austin Squires. 2nd edition. New Brunswick Museum, Saint John. Monographic Series No. 7. v + 220 pp., illus.

Checklist of the world's birds. A complete list of species, with names, authorities and areas of distribution. 1976. By Edward S. Gruson. Quadrangle (New York Times), New York. xii + 212 pp. \$10.95.

* **Environmental toxicity of aquatic radionuclides.** Models and mechanisms. 1976. Edited by M. W. Miller and J. N. Stannard. Ann Arbor Science, Ann Arbor. xv + 333 pp. \$26.50.

Field guide to Pacific fish. 1976. By David Somerton and Craig Murray. Douglas, Vancouver. 96 pp., illus. \$4.95.

* **Fishes of the world.** 1976. By Joseph S. Nelson. Wiley, New York. 416 pp., illus. \$24.

Physiology of the Amphibia. 1976. By Brian Lofts. Academic, New York. Volume 3. 520 pp. \$58.50.

† **Policy for Canada's commercial fisheries.** 1976. By anonymous. Environment Canada, Fisheries and Marine Service, Ottawa. 70 pp. + appendices. Free.

Botany

† **Illustrated flora of Illinois.** Sedges: *Cyperus* to *Scleria*. 1976. By Robert H. Mohlenbrock. Southern Illinois University Press, Carbondale. xii + 192 pp., illus. \$15.

Vascular plants of British Columbia. A descriptive resource inventory. 1977. By Roy L. Taylor and Bruce MacBryde. University of British Columbia Press, Vancouver. 772 pp. Paper approx. \$28.

Flora Europaea. Volume 4. Plantaginaceae to Compositae (and Rubiaceae). 1976. Edited by T. G. Tutin, V. H. Heywood, N. A. Burges, D. M. Moore, D. H. Valentine, S. M. Walters, and D. A. Webb. Cambridge University Press, Cambridge.

* **The chemotaxonomy of plants.** 1976. By Philip M. Smith. Edward Arnold, London (Canadian distributor Macmillan, Toronto).

The mosses of southern Australia. 1976. By George A. M. Scott and Ilma G. Stone. Illustrated by Celia Rosser. Academic, New York. 514 pp. \$46.

* **Spring flora of Wisconsin.** 1976. By Norman C. Fassett. 4th edition revised and enlarged by Olive S. Thomson. University of Wisconsin Press, Madison. 413 pp., illus. \$8.50.

* **Rocky mountain flora.** 1976. By William A. Weber. 5th edition. Colorado Associated University Press, Boulder. 477 pp., illus. Text edition \$9.50; trade edition \$12.50.

† **Modern methods in forest genetics.** 1976. Edited by J. P. Miksche. Springer Verlag, New York. xvi + 288 pp. \$23.80.

The seeds of dicotyledons. 1976. By E. J. H. Corner. Cambridge University Press, New York. Two volumes. Vol. 1: xii + 312 pp. \$39.50, and vol. 2: viii + 552 pp., illus. \$65.

Environment

† **Structure and dynamics of land use.** Écologie de la zone de l'Aéroport International de Montréal. 1975. By Peter Brooke Clibbon. Les Presses de l'Université de Montréal. xxix + 369 pp., illus. \$12.

† **The land that never melts.** Auyuituq National Park. 1976. Edited by Roger Wilson. Peter Martin, Toronto. x + 212 pp., illus + map. Cloth \$15; paper \$5.95.

An introduction to biological rhythms. 1976. By John D. Palmer. Academic, New York. 392 pp. \$19.50.

† **Ecology and management of animal resources.** Écologie de la zone de l'Aéroport International de Montréal. 1976. By

J. Roger Bider, Eric Thompson, and R. W. Stewart. Les Presses de l'Université de Montréal. xxii + 246 pp., illus. \$12.

The natural history of New Zealand. An ecological survey. 1973. Edited by G. R. William, A. H. Reed and W. W. Reed. Tuttle, Vermont. 434 pp., illus. \$27.95.

† **Nature quizzes for Canadians.** 1976. By Vicky and Bill McMillan. Douglas, Vancouver. 144 pp., illus. Paper \$3.95.

† **Le cadre d'une recherche écologique interdisciplinaire.** Écologie de la zone de l'Aéroport International de Montréal. 1976. By Pierre Dansereau. Les Presses de l'Université de Montréal. 343 pp., illus. \$12.

† **Plants and animals of the Pacific northwest.** An illustrated guide to the natural history of western Oregon, Washington, and British Columbia. 1976. By Eugene N. Kozloff. Douglas, Vancouver. ix + 264 pp., illus. \$17.50.

Other

† **Athlon.** Essays on paleontology in honour of Loris Shano Russell. 1976. Edited by C. S. Churcher. Royal Ontario Museum, Toronto. 286 pp., illus. \$15.

The uncertain future of the lower Fraser. 1976. Edited by Anthony H. J. Dorsey. University of British Columbia Press, Vancouver. 200 pp. Paper \$4.95.

Water publications of State agencies—first supplement. 1976. Edited by G. J. Giefer and D. K. Todd. Water Information Center, Huntington, New York. \$23.

† Available for review

* Assigned for review

THE OTTAWA FIELD-NATURALISTS' CLUB

BY-LAWS

(Approved by Council 15 November 1976)

1. *General Meeting*

The Club shall hold at least two general meetings each year at which the affairs of the Club shall be discussed. One such meeting, the Annual Business Meeting, shall be for the purpose of electing officers and additional members of the Council and for conducting such other business as shall arise.

2. *Fiscal Year*

The fiscal year of the Club shall be the calendar year.

3. *Duties of the Membership Committee*

The Membership Committee shall keep the Council informed of the state of the membership. It shall ensure that accurate records of memberships are maintained. It shall act as a liaison between the members and the Council on all matters respecting the conditions of membership. It shall recommend to the Council candidates for Honorary Membership.

4. *Duties of the Finance Committee*

At the commencement of each fiscal year the Finance Committee shall prepare for the Council's approval a statement of estimated revenues and a proposed allocation of funds for the year. It shall act in an advisory capacity to the Council in all matters concerning investments and disbursements of funds, and any other financial dealings and transactions of the Club.

5. *Duties of the Excursions and Lectures Committee*

The Excursions and Lectures Committee shall make arrangements for excursions, lectures, and other activities for the education and entertainment of members.

6. *Duties of the Publications Committee*

The Publications Committee shall supervise the policy, finances, and distribution of the Club's publications. It shall act in an advisory capacity to the Council in all matters pertaining to publications of the Club. The Publications Committee shall recommend Editors of each publication for approval by the Council. It shall appoint Associate Editors for each publication.

7. *Duties of the Nominating Committee*

A Nominating Committee, consisting of three members, shall be chosen by the Council early in the year. The President shall not be a member of the Committee and no Officer of the Club shall be chairman. The Committee will prepare a slate of Officers and candidates to be elected to the Council at the following Annual Business Meeting. It shall be the responsibility of the Committee to ensure that all members of the Club, whatever their place of residence, have a reasonable opportunity to make nominations. All nominations made to the Committee shall be made in writing, and shall include a statement from the nominee that he or she is willing to serve. No nominations will be received at the Annual Business Meeting, and the Nominating Committee shall ensure the presentation of sufficient candidates to satisfy the requirements of the Council as laid down in the Constitution.

8. *Special Committees*

Special Committees may be formed by the Council and delegated authority for specific tasks. Each Special Committee shall include at least one member of the Council who need not be chairman of the Committee.

9. *Duties of the Editors*

The Editor of each publication of the Club shall be responsible for the editorial policy, content, and preparation of that publication. Each Editor shall be a member of the Publications Committee and shall be responsible to that Committee. The Associate Editor(s) of each publication shall assist the Editor in the preparation of that publication.

10. *Business Managers*

A Business Manager for *The Canadian Field-Naturalist* shall be appointed as specified by the Constitution. In addition, the Council may appoint a Business Manager for any other publication or for the Club itself. The duties of the Business Managers shall be as specified by the Council.

11. *Treasurer's Assistant*

The Council may appoint a Treasurer's Assistant who shall be responsible solely to the Treasurer. The Treasurer will define the duties of the Assistant in consultation with the Business Manager(s) and the Chairmen of the Standing Committees.

12. *Disbursements of Club Moneys*

Disbursements of Club moneys shall be made by the Treasurer on receipt of properly rendered accounts verified by the Chairman of the Committee concerned, or by a Business Manager, or as specified by the Council. Disbursements of Club moneys shall be made only by cheque bearing the signatures of any two of the three following members of the Council: President, Treasurer, Business Manager of *The Canadian Field-Naturalist*.

13. *Order and Conduct of Business at Meetings*

The order of business at the Annual Business Meeting and meetings of the Council shall be:

1. Minutes of the previous meeting
2. Business arising out of the minutes
3. Communications
4. Treasurer's report
5. Reports of Committees
6. New business

The order of business may be changed by a unanimous vote of members present at such meetings.

All above meetings shall be conducted according to the Constitution, By-laws, special rules of the Club, and normal parliamentary procedure. In all cases where differences of opinion arise, Bourinot's Rules of Parliamentary Procedure shall be followed. Voting by Proxy will not be permitted at meetings of the Council.

14. *Annual Reports*

The Chairman of each Standing and Special Committee shall submit a report of the Committee's activities during the year to a meeting of the Council. The Recording Secretary shall prepare an Annual Report at the end of the fiscal year which shall include the minutes of the previous Annual Business Meeting and accounts of the activities of each Committee. The Annual Report shall be presented at the Annual Business Meeting and shall be published in *The Canadian Field-Naturalist*.

15. *Annual Dues*

The schedule of annual dues shall be as follows:

Memberships —

Individual: \$7.00

Family: \$9.00

16. *Subscription Fees*

The schedule of subscription fees shall be as follows:

The Canadian Field-Naturalist —

Individual: \$ 7.00

Libraries and Institutions: \$15.00

Trail & Landscape —

Libraries and Institutions: \$7.00

17. *Expulsion from the Club*

Any individual may be expelled from the Club for conduct or activities prejudicial to the objectives and well-being of the Club, by a two-thirds majority vote of the elected Council, the individual first having had an opportunity to defend himself before the Council prior to the vote being taken.

18. *Amendments*

An amendment to these By-laws may be adopted at any meeting of the Council, by a two-thirds majority of the members present, due notice embodying a copy of the proposed amendment having been given at a previous meeting of the Council. Any such amendment shall be published in an early issue of *The Canadian Field-Naturalist*.

Instructions to Contributors

Content

The Canadian Field-Naturalist is a medium for publication of scientific research papers in all fields of natural history. As the journal has a flexible publication policy, items not covered in the traditional sections (Articles, Notes, Letters, News and Comment, and Book Reviews) can be given a special place provided they are judged suitable. Naturalists are also encouraged to support local natural history publications.

Manuscripts

Please submit, in either English or French, three complete manuscripts written in the journal style. The research reported should be original. It is recommended that authors ask qualified persons to appraise the paper before it is submitted. Also authors are expected to have complied with all pertinent legislation regarding the study, disturbance, or collection of animals, plants, or minerals.

Type the manuscript on standard-size paper, if possible use paper with numbered lines, double-space throughout, leave generous margins to allow for copy marking, and number each page. Generally words should not be abbreviated but use SI symbols for units of measure. Underline only words meant to appear in italics. If only one or two references are cited, they can be inserted into the text. Follow the literature cited with the captions for figures (numbered in arabic numerals and typed together on a separate page) and the tables (each titled, numbered consecutively in arabic numerals, and placed on a separate page). Mark in the margin of the text the places for the figures and tables. For articles, provide a running head, a bibliographic strip, and an abstract.

Extensive tabular or other supplementary material not essential to the text should be submitted in duplicate on letter size paper for the Editor to place in the Depository of Unpublished Data, CISTI, National Research Council of Canada, Ottawa, Canada K1A 0S2. A notation in the

published text should state that the material is available, at a nominal charge, from the Depository.

The **CBE Style Manual**, 3rd edition (1972) published by the American Institute of Biological Sciences, is recommended as a guide to contributors. **Webster's New International Dictionary** and le **Grand Larousse Encyclopédique** are the authorities for spelling.

Illustrations—Photographs should have a glossy finish and show sharp contrasts. Photographic reproductions of line drawings, no larger than a standard page, are preferable to large originals. Prepare line drawings with India ink on good quality paper and letter (not type) descriptive matter. Write author's name, title of paper, and figure number on the lower left corner or on the back of the illustration. Two copies of figures in addition to originals are required for use by referees.

Special Charges

Authors must share in the cost of publication by paying \$40.00 for each page in excess of six journal pages, *plus* \$5.00 for each illustration (any size up to a full page), and up to \$40.00 per page for tables (depending on size). Reproduction of color photos is extremely expensive; price quotations may be obtained from the Business Manager. When galley proofs are sent to authors, the journal will solicit on a voluntary basis a commitment, especially if grant or institutional funds are available, to pay \$40.00 per page for all published pages. Authors may also be charged for their changes in proofs.

Limited journal funds are available to help offset publication charges to authors with minimal financial resources. Requests for financial assistance should be made to the Editor when the manuscript is submitted.

Reprints

An order form for the purchase of reprints will accompany the galley proofs sent to the authors.

Reviewing Policy of *The Canadian Field-Naturalist*

Manuscripts submitted to *The Canadian Field-Naturalist* are normally sent for evaluation to an Associate Editor and at least one other reviewer. Authors are encouraged to suggest names of suitable referees. Reviewers are asked to give a general appraisal of the manuscript followed by specific comments and recommendations. Almost all manu-

scripts accepted for publication have undergone revision—sometimes extensive revision and reappraisal. The Editor makes the final decision on whether a manuscript is acceptable for publication, and in so doing aims to maintain scientific quality and overall high standards of the journal.

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Corrigendum

1972. Canadian Field-Naturalist 86(3): 294. *Thayer's Gulls wintering off western Newfoundland* by R. G. B. Brown. At the time this note was published a lot less was known of Thayer's Gull (including the range) than is known now. Dr. Brown has already published a correction in the *Atlas of eastern Canadian seabirds*. This reads as follows: "Several winter identifications off western Newfoundland (Brown 1972b) are now thought to be doubtful." Although there is always a certain risk in publishing such sight records, even those made by competent professionals, we feel that, in total, the usefulness of these accounts greatly outweighs any harm. Certainly anyone making a compilation of sight records has to exercise judgment.

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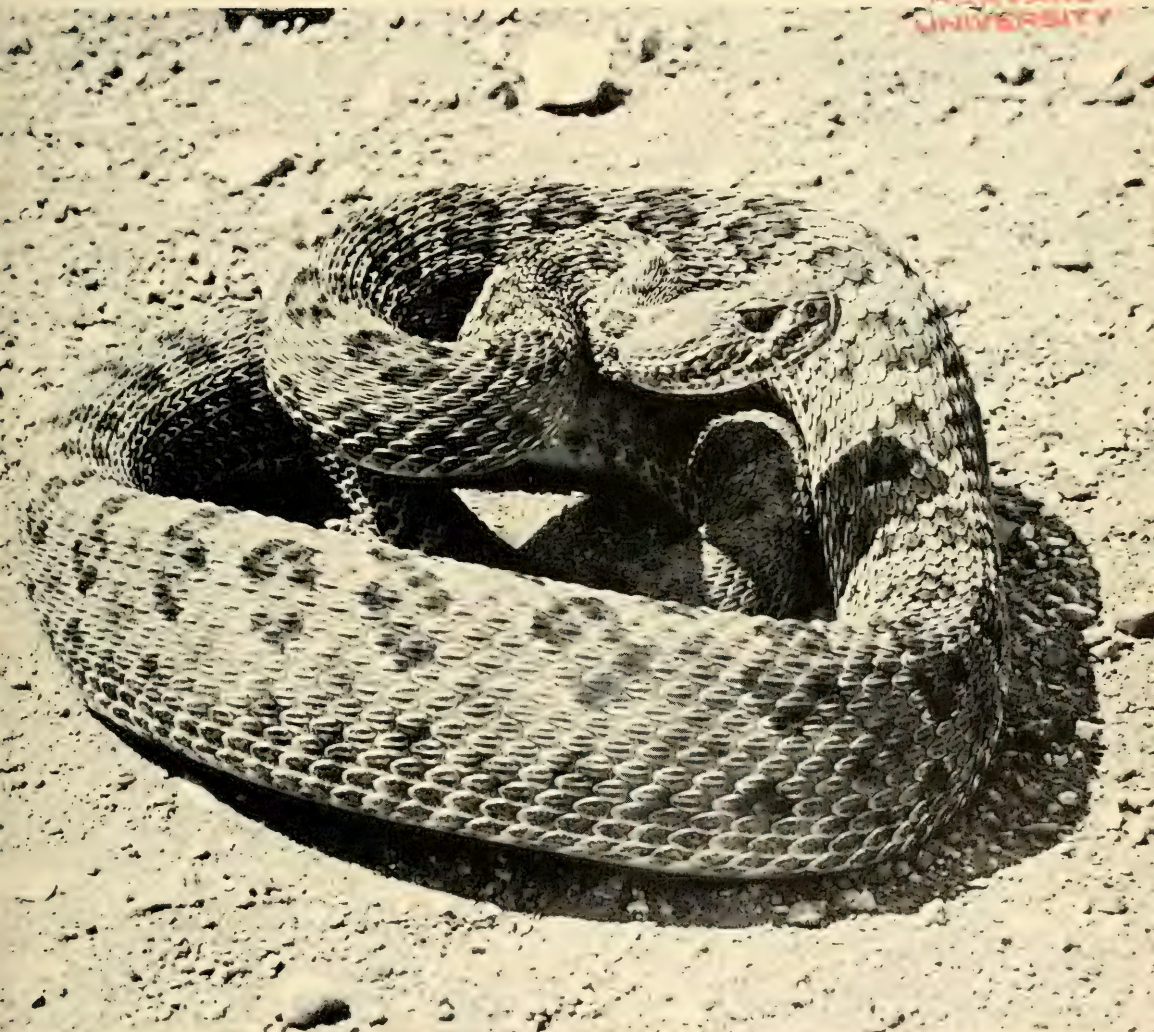
The CANADIAN FIELD-NATURALIST

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The Canadian Field-Naturalist

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All material intended for publication should be addressed to the Editor:

Dr. Lorraine C. Smith, Department of Biology, Carleton University, Ottawa, Ontario, Canada K1S 5B6

Cover: A vibrating tail (blurred) and characteristic striking coil warn that this Prairie Rattlesnake, encountered as it was making a midday crossing of a gravel road northwest of Medicine Hat, Alberta, should not be molested. Photo by George B. Pendlebury. See article page 122.

Editorial Policy

From time to time it is useful to state current editorial policy; not only does this remind or clarify to authors and readers our ongoing practices, but it also serves to introduce new, updated, or flexible policies. Journal editors normally endeavor to improve and standardize their publications. *The Canadian Field-Naturalist*, a medium for publication of original scientific research papers and notes on Canada's natural history, has earned a well-deserved reputation among scientists and naturalists; it is internationally recognized, listed in *Current Contents*, and financially supported by the National Research Council of Canada. It is an outlet for the work not only of scientists but also of well-informed amateur naturalists; that is, for all people who have significant contributions to make to our understanding of many aspects of natural history. The journal, of course, takes no responsibility for statements made by contributors.

Our aim is to keep the quality and overall standards of the journal as high as possible while continuing to serve our authors and readers. It is the Editor's responsibility to ensure that the journal continues to fulfil its present important role of recording, interpreting, and communicating information on Canadian natural history phenomena. Because we are striving to improve the standards of scientific writing so it is clear, well organized, concise, simple, logical, and *interesting*, we often help authors to rewrite, sometimes to reorganize, to prune, and generally to improve their manuscripts. By doing this we are often able to salvage and eventually publish papers that we would otherwise reject; at the same time we are upholding the standards of the journal.

To communicate their work properly, authors need to take into account the requirements of the average reader; it is especially important for our authors not to isolate themselves in their disciplines. Because many journals now cater to specialists, we hope that *The Canadian Field-Naturalist*, with its broad coverage of subjects and its many-sided approaches to natural history, will help to integrate studies and have a generalizing influence in the world that is becoming increasingly specialized. Although specialized papers do have a place in the journal, it is best to remember that they become more important if they are interpreted for readers other than specialists in the field of the paper. Moreover, if their message is interesting enough to be recorded in the primary scientific literature, then it should be conveyed clearly and as concisely as possible. As well, authors owe it to themselves to present their data in the best possible way. Perhaps the most common comments an editor makes are "spell out more clearly" and "rewrite more succinctly." But we often have to tell authors, "Focus on the stated objectives and tell us the advance in science and its significance, put your contribution into perspective with what is known about the subject, delete ancillary material and parts that are redundant, and make your writing more direct and less complex." For simplicity and clarity authors are also encouraged to use the first person and the active voice.

We will not publish manuscripts that are scientifically unsound, are unoriginal, lack sufficient worthwhile new information, have been published elsewhere, or are not relevant. Preliminary studies or piecemeal submissions are also generally not acceptable.

Referees are encouraged to make constructive comments basing their appraisals on sound scientific knowledge and experience and on the significance of the contribution to the ever-expanding literature. If they choose to do so, and most do, they may remain anonymous. I am convinced that the present referee system, although not perfect, is both good and essential and especially so for our

journal, as the Editor cannot be cognizant with all fields of natural history. Broadminded authors, however, do make the Editor's work easier. Often opinions are divergent and the Editor must make the final decision whether a paper is acceptable for publication. Although authors are always free to rebut the criticisms of referees and the decision of the Editor, their refutations should be based on sound arguments.

Content

We are, of course, aware that not everyone agrees with our editorial policies. Therefore, on occasion, we try to take a fresh look at the appropriateness of the manuscripts we publish. For example, although some journals are no longer accommodating descriptive studies and similar papers, *The Canadian Field-Naturalist* will continue to accept these if they contain data basic to the advancement of science. There is, however, no need for the journal to publish most management or laboratory studies as other outlets are more appropriate. But the journal does not limit itself to field studies, because laboratory, museum, and other studies may have considerable significance to the field situation. Thus the subjects of all manuscripts are given objective consideration. The journal, however, must remain true to its original purpose, that is, to give primary consideration to manuscripts that help elucidate and have some basic relevance for Canadian natural history. Studies done outside Canada are eligible for submission provided they meet this requirement for content; for example, ecosystems and/or biotas in the northern United States are often the same as those in Canada.

Should we continue to publish range extensions? Last year Associate Editor David P. Scott wrote, "I am more and more concerned with the amount of space which is being devoted to range extensions and/or speculative zoogeography. I wonder if you could consider the idea of having a single annotated list of new ranges published once a year rather than a series of notes and papers as is presently the case?" I solicited the opinions of all our other Associate Editors as well as other interested and concerned persons and received widely divergent views. An editorial by Dave Scott will be published in an early issue of the journal to elaborate on his opinion and to comment on other views. Certainly there are advantages to having a much-reduced and standardized style, but the topic is an important one and no decision will be taken without carefully weighing the pros and cons. For the time being, therefore, the current method of reporting range extensions will be continued; the merit of each paper and whether the range extension is significant will be judged individually by competent referees.

Occasionally our practice of publishing sight records (that is, records not supported by either a specimen or a photograph) is questioned. Of course, there is always a certain risk in publishing sight records, even those by competent professionals, but we feel that, in total, the usefulness of these accounts outweighs their harm. Generally the species concerned are reasonably easy to identify and experienced observers clearly detect the diagnostic characteristics. Certainly anyone compiling and analyzing sight records has to appraise each one carefully.

Another contentious subject is "lists." In general we would like to discourage submission of long annotated lists of species with detailed information about each. This does not imply that we consider such lists as unimportant or of too little significance to be recorded but, based on their scope and the limited new information or insights they contain, they are usually not appropriate for the journal. These long catalogues should certainly be available but in most cases they should be published, or otherwise made accessible, by an appropriate government agency.

It is refreshing to consider different types of manuscripts that will add a new dimension to the journal. I am pleased to report that we expect to initiate fairly soon a new series on the vascular plant flora of Canada. Information on this venture and the format for the accounts will be elaborated on by Associate Editor George La Roi in an upcoming issue of the journal.

Style

Our suggested guide to authors regarding style is the *CBE Style Manual*. *Webster's Dictionary* is our authority for English spelling. We request that all units of measure be expressed in the metric system and that authors use SI symbols. Other matters regarding *The Canadian Field-Naturalist's* format and style can be ascertained by consulting the Instructions to Contributors or by looking over current journal issues.

One subject about which the journal has never had a firm policy is whether the names of the authors of scientific names should accompany the scientific names in all papers. Our Editorial Board could not agree on this although the majority felt that the names of authors of scientific names should be included only for taxonomic or other papers where nomenclatural problems are involved. Therefore, unless an author is adamant, we intend to delete references to authors of scientific names except for taxonomic or other papers where the names are in a state of flux, as they are for some plant groups, many invertebrates, and many microorganisms. If a paper treats many species, a reference for the scientific names should be cited.

We prefer authors to use "proper" common names for plants and animals throughout their papers unless there is a specific reason not to do so. Normally we have not capitalized the initial letters of common names, except in the case of birds where there is a list of capitalized "official" or "proper" names accepted by a learned society, the American Ornithologists' Union; only certain insect names are capitalized in accordance with the list approved by the Entomological Society of America. We suggest that the initial letters of common names of other species of organisms should also be capitalized but at the moment will leave the decision on this up to individual authors. A species should be identified the first time it is mentioned in the abstract and in the text, preferably by putting the scientific name in parentheses following the common name. Generic names are written out in full the first time they are mentioned and thereafter may be abbreviated if it is unequivocally clear to which genus the initial refers.

For consistency in nomenclature in non-taxonomic papers, we have adopted a policy for authors to follow certain mandatory or recommended references for the scientific and common names of organisms. For names of mammals and birds we require authors to use the following references.

Mammals

Jones, J. Knox, Jr., Dillard C. Carter, and Hugh H. Genoways. 1975. Revised checklist of North American mammals north of Mexico. *Occasional Papers, The Museum, Texas Tech University* 28: 1-14.

Birds

American Ornithologists' Union. 1957. Check-list of North American birds. 5th edition, Baltimore. 691 pp.

American Ornithologists' Union. 1973. Thirty-second supplement to the American Ornithologists' Union check-list of North American birds. *Auk* 90: 411-419. Also Corrections and additions to that supplement, 1973, *Auk* 90: 887.

American Ornithologists' Union. 1976. Thirty-third supplement to the American Ornithologists' Union check-list of North American birds. *Auk* 93: 875-879. Also future supplements.

Although the scientific and common names of other animals and plants seem to be less standardized than those of mammals and birds, the following list of publications may be helpful to authors as references for nomenclature.

Amphibians and Reptiles

Conant, Roger. 1975. A field guide to reptiles and amphibians of eastern and central North America. 2nd edition. Houghton Mifflin, Boston. 429 pp.

Stebbins, Robert C. 1966. A field guide to western reptiles and amphibians. Houghton Mifflin, Boston. 279 pp.

Fishes

American Fisheries Society. 1970. A list of common and scientific names of fishes from the United States and Canada. 3rd edition. American Fisheries Society Special Publication 6. 150 pp.

Scott, W. B. and E. J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada Bulletin 184. 966 pp.

- Leim, A. H. and W. B. Scott. 1966. Fishes of the Atlantic coast of Canada. Fisheries Research Board of Canada Bulletin 155. 485 pp.
- McPhail, J. D. and C. C. Lindsey. 1970. Freshwater fishes of northwestern Canada and Alaska. Fisheries Research Board of Canada Bulletin 173. 381 pp.
- Hart, J. L. 1973. Pacific fishes of Canada. Fisheries Research Board of Canada Bulletin 180. 740 pp.

Vascular Plants

- Hosie, R. C. 1969. Native trees of Canada. 7th edition. Queen's Printer, Ottawa. 380 pp.
- Fernald, M. L. 1950. Gray's manual of botany. 8th edition. American Book Co., New York. 1632 pp.
- Gleason, H. A. 1952. The new Britton and Brown illustrated flora of the northeastern United States and adjacent Canada. 3 volumes. (5th printing, 1974.) Published for the New York Botanical Garden by Hafner Press, New York. Volume 1, lxxv + 482 pp.; Volume 2, iv + 655 pp.; and Volume 3, iii + 595 pp.

Manuscripts

Before submitting a manuscript to *The Canadian Field-Naturalist*, authors should be certain that the publication is not premature, this journal is the proper outlet for their work, the contribution is a significant and new contribution to the scientific literature, the biology is emphasized, and they have followed the Instructions to Contributors. Their study, as reported, should be reasonably complete and comprehensive. Often manuscripts would benefit from more peer review before submission.

The journal tries to restrict the papers published to natural history ones of national interest, i.e., papers with primary (new) information or with new insights. Therefore, authors whose papers are mainly of local interest are advised to submit their papers to regional journals. Certain specialized subjects, e.g., wildlife management, statistical studies, pollution monitoring, detailed anatomical studies, extensive lists of the flora and fauna of an area, or papers that rehash earlier ones are also best submitted elsewhere.

It is rare for a manuscript to be accepted for publication as it is submitted. Sometimes a paper, returned to an author for revision, is resubmitted without the requested changes and with no explanation or rationale for ignoring the criticisms. It is then impossible for an editor to judge such a paper fairly. Other times an author will state the importance of his research in a letter. One can only ask the author, "Why didn't you say that in your manuscript?"

Most submitted manuscripts are too long. With the current expansion of the scientific literature, journals should publish only clear and concise write-ups; all unnecessary data, detail, and discussion must be deleted. Material that is supplementary to the published text may be directed to the Depository of Unpublished Data.

A few suggestions and comments are offered to authors here because the same faults and shortcomings recur so often. Make the paper's title descriptive and the sequence of the paper logical and orderly. Include a clear statement of purpose, rationale, and scope of the study in the Introduction. Put the study in the proper perspective with what is already known on the subject but limit the literature review to defining the problem at hand. Avoid extreme speculation with no basis in fact, subjective observations, excessive use of "weasel" words, and unwarranted conclusions. When citing a personal communication give the person's initials and address. In the Results and Discussion make sure your statements are supported by data, the number of significant figures in the numerical data is not greater than warranted by the precision of your experimental method, and the work reported is reasonably complete and comprehensive. Point up the significance of your own results and limit the space devoted to outlining the results of others. Be careful with your terminology. For example, although "parameter" is often used indiscriminantly to mean any variable that can be measured, its original meaning restricts the term to a quantity that in any particular case is fixed or constant. Thus in the simple equation $y = a + bx$ the parameters are a and b while the variables are x and y .

The number of figures and tables should not be larger than is necessary to convey the message. Figure captions and table legends should give the purpose of the figure or table, and not just point out what they contain. Many figures require a scale, e.g., a scale line or bar to indicate a distance.

This reference line should be placed directly on the figure itself, not in the caption, so that it will be valid when the figure is reduced for printing. Graphic material should stand on its own without reference to the text. If original figures are larger than a normal page, it would make life easier for us if they were submitted as page-size (or smaller) photographic reproductions.

Some authors write their acknowledgments with everyone in mind. It is logical to acknowledge the sources of financial aid, data, and illustrations, and to thank those who have given considerable help with the research or writing. Others, however, who have helped with the paper in a broad sense, or in a minor way, should remain anonymous. Normally, as titles before people's names do not add anything, we delete them.

Invariably some of the references in the Literature Cited don't agree with those in the text and often some are incomplete. Careful proofreading beforehand would avert these errors. Unfortunately we do not have the staff and facilities available, as do some journals, to check out all the references. Because of this and because of the number of disciplines we cover, we have found it easier to ask authors to write out the names of journals in full despite the common use of abbreviations elsewhere. Nevertheless, many authors would prefer to use standard abbreviations. Therefore, it seems wise to give this a trial. Consequently we will allow authors to abbreviate names of serials and request that they follow the abbreviations listed in the *Bibliographic guide for Editors and Authors*. The onus must be on the author to ensure that the abbreviations used (as well as dates, pages, etc.) are correct because in many cases we will be left with little choice but to publish them as submitted. If there is any doubt about clarity, then the references should be written out in full. Usually initials are substituted for the given names of authors in the Literature Cited. Nevertheless if authors wish it, we are willing to publish the given names provided they were used originally.

With the ever-increasing variety of methods of replicating and distributing written works, it is becoming increasingly difficult to know if, or how, to cite them. The members of our Editorial Board have agreed that we should retain Literature Cited and not change to References Cited or References. It was felt that the essence of good science is that anyone should be able to check not only the conclusions from a quality paper but also the references. Literature Cited comprises works that have been referred to in the text and that have been published, scheduled for publication (please note that this does not apply to manuscripts that have been merely submitted to a journal but not yet accepted), or deposited in libraries as theses; i.e., they are readily available. It does not contain unpublished references such as reports, memoranda, data sheets, internal documents, projects by university honor students, agency reports, consultants' reports etc. Some of these exist only as a few copies while others are reproduced for limited distribution as xerographic copies or mimeographed sheets but in general most are not readily accessible. Even if the report is more widely distributed, e.g., nest record scheme reports, we discourage their use. In any case they are not literature and hence can be referred to only in the text.

Page references in a book can be of value when they are given in the text for specific points. But how useful is it to conclude in a reference the number of pages in a book? In the past we have asked authors to include the total pagination. Although this may be useful as a guide to finding a book on library shelves or perhaps helps to give a reader an idea about the scope of the book, the number of pages does not seem otherwise of value; henceforth we will not specifically ask authors for this. We will, however, include this information if it is provided.

I conclude this editorial with the thought that we have an open mind regarding many editorial policies. If we are convinced that it is time to change, revamp, or otherwise alter our policies, then we will do so. Responses of our authors and readers to this editorial or to any other matters concerning the publication of *The Canadian Field-Naturalist* are welcomed.

LORRAINE C. SMITH,
Editor

Distribution and Abundance of the Prairie Rattlesnake, *Crotalus viridis viridis*, in Canada

GEORGE B. PENDLEBURY

304 Manora Rd., N.E., Calgary, Alberta T2A 4R6

Pendlebury, George, B. 1977. Distribution and abundance of the Prairie Rattlesnake, *Crotalus viridis viridis*, in Canada. Canadian Field-Naturalist 91(2): 122-129.

Abstract. The Prairie Rattlesnake, *Crotalus viridis viridis*, reaches the northern limit of its range in southeastern Alberta and southwestern Saskatchewan. The dominant limiting factor is likely the presence of a dry steppe climate. But, within this climatic zone, bedrock geology has played an important role in localizing den sites, and indirectly, in providing a suitable substrate. With greater human population pressure, and particularly the increased use of irrigation, the range of *C. v. viridis* has decreased over the past few decades. Prairie Rattlesnakes are most abundant in, and in close proximity to, major river valleys where irrigation is usually not practised, and where suitable den sites are developed.

The widely distributed Prairie Rattlesnake, *Crotalus viridis viridis*, reaches the northern limit of its range in southern Alberta and Saskatchewan. Klauber (1956), Wright and Wright (1957), Conant (1958), and Stebbins (1966) included portions of these provinces in their range maps for the species. Williams (1946), Logier and Toner (1961), Lewin (1963), Cook (1965), and others have reported Canadian capture locations.

This study was undertaken in an attempt to define better the range of *C. v. viridis* in Canada, and reveal some of the factors which influence its distribution. The sources of locality data used were (1) museum specimens, (2) published reports, (3) my own observations and collections, (4) answers to mailed questionnaires, and (5) reliable reports made to others.

Method

Rattlesnakes are distinctive (Figure 1) in many respects and not generally confused with the other snake species which occur in Alberta and Saskatchewan. For this reason, I believed it might be possible to supplement existing distribution data by mailing a questionnaire to towns within the study area.

The questionnaire pertained only to rattlesnakes and was organized so that most of the questions could be answered by marking an 'X' in the appropriate space after each question. The questionnaires and stamped, self-addressed envelopes were mailed to the postmasters of just over 100 selected towns in southern Alberta and

Saskatchewan. Ninety-nine replies were received.

Several advantages of this approach were that (1) the questionnaires could be mailed to a specific person in each town, (2) the organization of the questionnaire and the stamped, self-addressed envelope required no expense and little time on the part of the recipient, (3) the questionnaires were received, answered, and promptly returned by the postmasters in their respective post offices, and (4) each reply was likely based on the collective knowledge and experience of several individuals since rural postmasters generally come in contact with most of the local people.

The main disadvantages inherent in data acquired with this method were (1) the imprecise locality data, and (2) the subjectiveness of replies concerned with abundance. In spite of these drawbacks, the data showed an amazing degree of coherence when plotted and analyzed.

Distribution of Prairie Rattlesnakes

Climatic changes subsequent to the end of Wisconsin glaciation 11 000 years ago fostered the establishment of prairie grassland in the southern parts of Alberta and Saskatchewan, continuous with the Great Plains of the United States. The southern grassland fauna moved northward into Canada along river valleys such as the Missouri and its tributaries. Once in Alberta, dispersion occurred along the valleys of existing rivers as well as those of abandoned meltwater channels (Williams 1946). Routes



FIGURE 1. The typical striking coil of a prairie rattlesnake. As part of a long-term project, color-coded vinyl discs have been affixed to the second proximal segment of the rattle to facilitate positive identification of this specimen from a distance. Photographed at a den site 4.6 km west of Redcliffe, Alberta.

likely followed by rattlesnakes are shown in Figure 2.

Naturally occurring populations of *C. v. viridis* in Canada are restricted to the prairie and foothills grassland vegetation zones of Alberta and Saskatchewan. These zones encompass, with the exception of upland areas, most of the southern regions of these provinces. The climate of this area is classified as moist to dry steppe (Longley 1972).

The limit of continuous distribution of the Prairie Rattlesnake in Canada is shown in Figure 3. In Saskatchewan the range consists of two components separated by 150 km. The southern portion includes the area south of the

Cypress Hills, Wood Mountain highlands which extend from the Alberta-Saskatchewan border to just west of Killdeer. The northern segment follows the South Saskatchewan River a distance of 60 km from the Alberta-Saskatchewan border to a point south of Eaton.

The range of the Prairie Rattlesnake in Alberta is continuous and joins the two Saskatchewan segments. The limit extends west to a longitude of $112^{\circ}53'00''$ and north to a latitude of $51^{\circ}22'00''$. Two particularly interesting aspects of the range in Alberta are that the lobes extend 55–65 km to the northwest and west from the main part of the range, and that three of these lobes are bisected by major rivers.

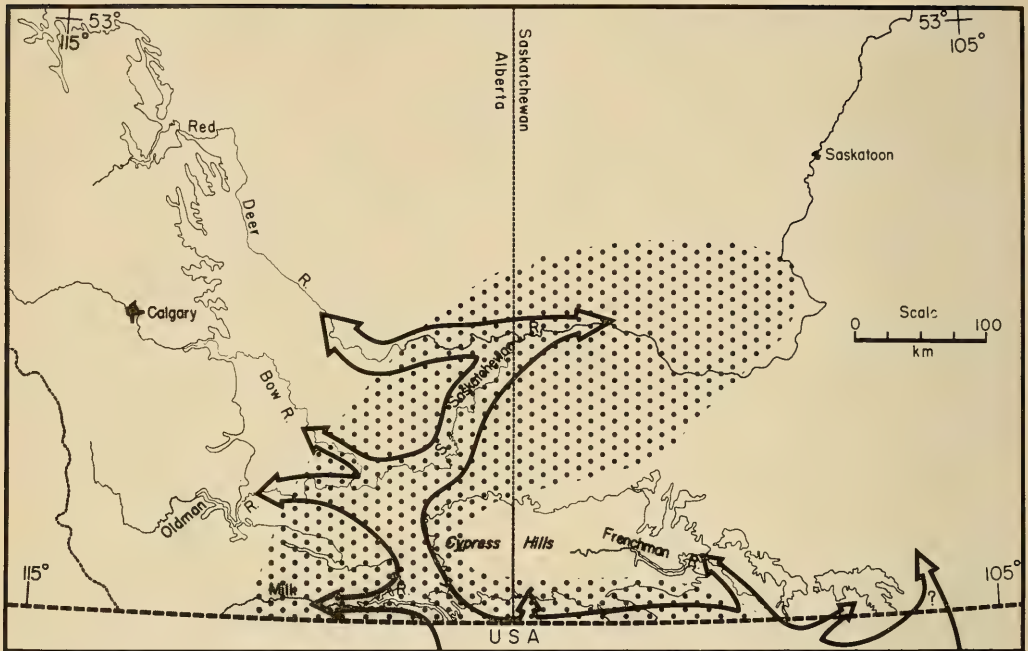


FIGURE 2. Dispersal routes likely used by *Crotalus v. viridis*. Shading represents areas with an elevation in excess of 1000 m; stippling represents the area of dry steppe climate (after R. W. Longley 1972).

From south to north these are the Oldman, Bow, and Red Deer Rivers. Possible reasons for this curious distribution will be discussed later.

Records from outside the Present-day Continuous Range

A number of locality records outside the present-day continuous range are indicated in Figure 3. The most northerly occurrence in Alberta is based on the 1943 report of a rattlesnake found on a farm near Trochu. The snake was apparently under a window and rattled as a cowhand was going to lean over the sill. The animal's life was spared but no other rattlesnakes have been reported from this area (M. J. Hampson, personal communication). The proximity of this occurrence to Ghostpine Creek, a tributary of the Red Deer River, and a Drumheller occurrence lead me to believe this is a valid record, and not a result of an accidental introduction. The Drumheller record is based on a specimen killed in July 1957 at a point 0.8 km

upstream from the bridge over the Red Deer River at Drumheller (C. F. Everts, personal communication).

The locality 100 km east-southeast of Calgary is based on Fowler's (1934) statement that the Prairie Rattlesnake is found 80.5 km east of High River.

An interesting newspaper account from 1934(?) mentions that a young rattlesnake was found basking on a sandbar at the junction of Sheep Creek and the Highwood River. This location is 21.6 km south-southeast of Calgary. R. L. Fowler states in a letter to C. L. Patch dated 9 October 1934 that he was unable to verify the account but took it to be true.

Rattlesnakes have been found, although rarely, in the vicinity of Saskatchewan River Crossing, south of Matador. Cook (1965) suggested that these occurrences might be the result of downstream rafting on debris.

The records from Cypress Hills, Belanger Creek, and Eastend, reported by Logier and

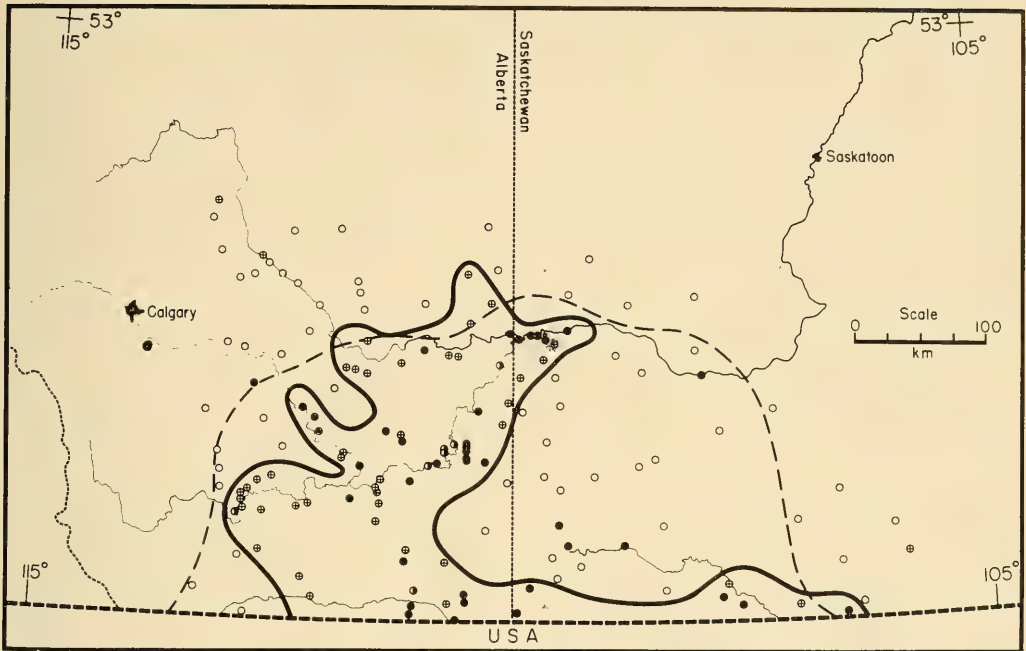


FIGURE 3. Data used to determine the distribution of *Crotalus v. viridis* in Canada. The solid line represents the present-day limit of continuous range; the dashed line is the limit according to Stebbins (1966). Symbols are as follows: solid circles = museum specimens and literature reports; half-solid circles = personal observations and collections; circle with dot = occurrences based on reports to sources other than myself; circle with cross = positive responses to the questionnaire and other occurrences reported to the writer; open circle = negative answers to the questionnaire.

Toner (1955, 1961), were based on information obtained by L. M. Klauber during 1935–1938 by means of a postcard questionnaire. In reply to my questionnaire, the postmasters of Cypress Hills and Eastend indicated that rattlesnakes are absent in their respective areas. Hence, either the range has decreased or these occurrences were the result of chance migrations up the valley of the Frenchman River, a tributary of the Missouri River.

All records from outside the present-day continuous range are at least 19 years old, and localities furthest from the limit are amongst the oldest. It is unlikely that these occurrences represent migrations from den sites. The meagre evidence available from Alberta indicates that seasonal movements are generally less than 4.3 km. Therefore, it is likely that the range of *C. v. viridis* in Canada is shrinking. Dinosaur Provincial Park at Steeveville, Alberta, boasts of

not having any rattlesnakes, yet the species was abundant here in 1912 (G. Lancaster, personal communication).

Accidental translocation of *C. v. viridis* is not uncommon and a number of examples were brought to my attention during this investigation. Mrs. O. M. Schafer of East Coulee, Alberta, wrote to me in 1972 "A live rattlesnake came in on a boxcar from eastern Alberta about 15 years ago." The University of Alberta has a specimen that is suspected of having arrived at Edmonton in a load of hay from Montana (National Museum of Natural Sciences records). Another rattlesnake was found at a petroleum exploration drill-site just south of Edmonton. This animal had apparently crawled into some pipe lying on the ground when the rig was previously drilling in the Medicine Hat area (W. E. McKay, personal communication). A correspondent from Shaunavon, Saskatchewan,

wrote that "some have been known to come in with shipments of Alberta hay." None of the accidental movements are plotted in Figure 3.

Factors Influencing Distribution

The distribution of *C. v. viridis* in Canada corresponds very closely to the dry steppe climatic zone (Figure 2) and it may be that climate is the dominant limiting factor. But I believe that, at least locally, there are other important controls. In my opinion, the bedrock and surficial geology has always exerted considerable influence on the distribution of *C. v. viridis* in Canada while, in the last two decades, a changing pattern of land use has contributed to significant changes.

The curious lobed pattern of the range in Alberta may be due simply to the fact that the valleys of rivers bisecting these lobes were used as dispersal routes but bedrock geology is also involved. Figures 3 and 4 demonstrate the great degree of similarity in areal distribution of the Prairie Rattlesnake and bedrock of the Upper Cretaceous Belly River Formation. As a result of

fluvial erosion into nearly horizontal strata, the Belly River outcrop pattern tends to follow valleys as evidenced by the sections along the Milk, Oldman, Bow, and Red Deer Rivers. The bedrock pattern also emphasizes a number of abandoned channels. The rocks which constitute these strata are dominantly siltstones and very fine-grained sandstones with subordinate shales. The porous and poorly indurated sandstones absorb surface water readily and the interbedded shales act as gliding planes when saturated (Williams and Dyer 1930). Slumping is common along coulees, stream courses, and other places of pronounced relief (Powers 1931). The resulting fissures and caverns provide sites suitable for hibernacula, particularly where modified and enlarged through the burrowing activities of small mammals.

Belly River sandstone outcrops contributed a large amount of material to overlying glacial deposits (Williams and Dyer 1930). The resulting well drained sandy subsoil forms a 'dry belt' which "... is nearly coincident with the outcrop of the Belly River Formation, but extends



FIGURE 4. Areas of Belly River (Foremost and Oldman) bedrock, and areas under irrigation in Alberta.

farther south where glaciation has distributed the Belly River sands over the Pierre Bearpaw shale" (Williams and Dyer 1930). This soil likely forms a more favorable substrate for *C. v. viridis*. The surrounding bedrock is Bearpaw shale which has a tendency to "... weather to banks of earthy appearance" (Williams and Dyer 1930). Except where covered by Belly River sands, the soils overlying the Bearpaw are relatively poorly drained and thus provide a less suitable substrate.

The hiatus separating the two Saskatchewan segments of the range was thought by Cook (1965) to result from a lack of available den sites. This may very well be the case, and may be related to bedrock geology. Most of the area is underlain by Bearpaw shale. Although the Belly River is present around the southern and eastern margins of a large Bearpaw outlier that straddles the Alberta-Saskatchewan border (Figure 4) the subdued topography results in few bedrock exposures and an absence of slump structures which play a significant role in den localization. Another factor contributing to the hiatus is the presence of unsuitable habitat associated with the Cypress Hills - Wood Mountain trend. These physiographic features rise to a maximum of 730 m above the general level of the surrounding prairie. These landforms affect local weather conditions to the extent that precipitation and water supply are more abundant in their vicinity (Williams and Dyer 1930). These local variations in climate are naturally accompanied by changes in vegetation. Only eight occurrences within the present-day continuous range were at elevations in excess of 1000 m (Figures 2 and 3).

Changing land use is another factor which is exerting an important effect on rattlesnake distribution, particularly in Alberta. Increasing amounts of rangeland are being turned over to cultivation, and irrigation is required in many areas. Increased agricultural activities caused the Prairie Rattlesnake to be pushed out of parts of Kansas and Nebraska, and irrigation of California's Imperial and Coachella valleys resulted in decreased numbers of Sidewinders, *Crotalus cerastes laterorepens* (Klauber 1956). It appears that *C. v. viridis* is suffering the same fate in Alberta.

Comments from two of my correspondents are noteworthy. "Since the irrigation arrived in this area, this has gradually pushed the snakes into the coulees along the South Saskatchewan River and south into the Forty Mile Coulee" (A. K. Bateman, personal communication). "It is common belief rattlesnakes do not live in irrigation districts ... Princess is lease land (dry pasture) and there are a few more seen in this area than Patricia" (Postmaster at Princess, personal communication).

Imagery acquired by the earth-orbiting ERTS-1 satellite was used to map areas under irrigation (Figure 4). Synoptic coverage combined with adequate resolution conferred an advantage on imagery over conventional aerial photography. The signature of infrared radiation reflected from vegetation is strongly dependent on plant type and vigor. Hence, the 0.7-0.8 μ (near infrared) band was found to be particularly useful for differentiating between irrigated areas under intensive cultivation, and areas of grain crops and rangeland.

Figures 3, 4, and 5 indicate that rattlesnakes are not always excluded from irrigated areas. This is particularly evident in the southwestern lobe of the range near Lethbridge. This apparent anomaly may be reconciled, however, if the area's topography and bedrock exposure are considered. Coulees are numerous and deeply eroded, exposing Belly River strata. The intervening areas are irrigated and cultivated, but the coulees themselves are not. Thus, peninsulas of favorable habitat extend from the valley of the Oldman River into less hospitable environs. Similar situations exist elsewhere in the province.

Abundance

Questionnaire recipients were asked to indicate whether rattlesnakes, if present in the immediate vicinity of their respective towns, were rare, common, or abundant. As already noted, replies to such a query are necessarily very subjective, and yield results which are semi-quantitative at best. This is particularly true when they are not based on an organized census. There is, unfortunately, no way of assigning a meaningful numerical range of values to each of the categories. The results, when plotted and

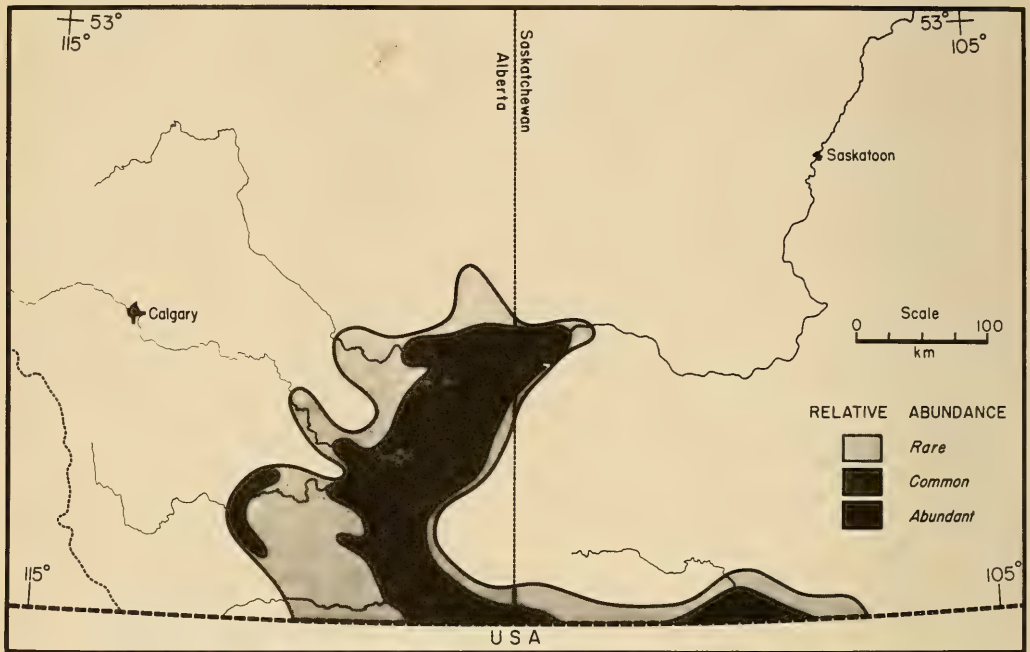


FIGURE 5. Abundance of *Crotalus v. viridis* in Canada.

contoured, generated the pattern shown in Figure 5. The 'abundant' category straddles the valleys associated with major rivers. Relative abundance decreases away from the river valleys and in an upstream direction through the distribution lobes in Alberta. An anomalous situation exists near the range limit in the southwestern Alberta lobe where rattlesnakes are said to be common. A possible explanation was discussed in the preceding paragraph. The closest area of 'abundant' occurrence lies 35 km to the east. The intervening area of 'rare' occurrence results from the fact that tributary coulees are less common, and those present are not as deeply eroded, i.e., favorable strata are not exposed. Furthermore, this area lies within an irrigation belt (Figure 4).

Fluctuations in numbers were mentioned by four correspondents. In Alberta, the postmaster at Ralston said, "This year [1972] rattlesnakes are rather scarce . . . guess it just has not been hot enough." The postmaster at Wardlaw, however, believed rattlesnakes " . . . are becoming more

common." Contradictory opinions were also obtained from two points in Saskatchewan. The postmaster at Burstall wrote, "More than average were seen here in 1973," while " . . . in the vicinity where McEachern Post Office was, rattlesnakes are rare, they were more abundant a few years back" (local resident, personal communication).

Conclusions

The results of this investigation lead to a number of conclusions:

1. Although distribution of *C. v. viridis* in Canada is controlled by many factors, available evidence indicates that, after climate, bedrock geology and land use are two of the more important controls.
2. Bedrock geology has contributed to suitable habitat in two ways: (1) the mechanical properties of the Belly River Formation lead to slumping with the concomitant formation of suitable den sites, and (2) soils derived from the Belly River sandstones are well

- drained and form a more suitable substrate.
3. A change in land utilization from rangeland to irrigated cultivation and the attendant habitat modification is restricting *C. v. viridis*, more and more, to the immediate vicinity of coulees.
 4. Increased pressure from the human population in the future will result in a continuous decrease in the range of the Prairie Rattlesnake in Canada.

Acknowledgments

I am indebted to F. R. Cook, National Museum of Natural Sciences, and M. J. Hampson, then of the Provincial Museum and Archives of Alberta, for providing distribution data. ERTS-1 imagery was kindly provided by R. G. Agarwal. Special thanks are extended to the 99 postmasters who answered and returned my questionnaire. W. B. Preston and L. Molinsky read the manuscript and offered suggestions for its improvement.

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Population Fluctuations of Wapiti (*Cervus elaphus*) and Moose (*Alces alces*) in Riding Mountain National Park, Manitoba, 1950–1976

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Rounds, Richard C. 1977. Population fluctuations of wapiti (*Cervus elaphus*) and moose (*Alces alces*) in Riding Mountain National Park, Manitoba, 1950–1976. *Canadian Field-Naturalist* 91(2): 130–133.

Abstract. Trends in populations of wapiti and moose in Riding Mountain National Park, Manitoba, are reviewed for the period 1950–1976. The wapiti population underwent rapid population changes during which four peak populations of between 4500 and 6000 animals alternated with four low populations of approximately 2000. The moose population increased slowly from approximately 250 in the early 1950s to more than 2000 in the early 1970s. The two populations changed independently prior to 1965, but appear to have oscillated in a related pattern during recent years.

Wapiti (*Cervus elaphus*) and moose (*Alces alces*) are indigenous to Riding Mountain National Park, Manitoba. Wapiti were reported to be plentiful prior to and during early settlement (to 1890), and their numbers were likened to those of the bison (*Bison bison*) by natives of the area. The herds summered in the present park area and wintered on surrounding prairies (Green 1933).

With intensified settlement, the herds were reduced by both slaughter and loss of habitat. In 1890, wapiti were plentiful, but their numbers were diminishing, and by 1900 only a "few hundred" remained. Green (1933) attributes survival of a nucleus herd to the formation of the Riding Mountain Dominion Forest Reserve in 1903.

In 1914 an estimated 500 wapiti remained. After several years of protection from hunting, the herd was estimated to contain 2500 animals in 1925. The population continued to increase to approximately 3500 by 1933 (Green 1933). Although early records are too incomplete to reveal fluctuations in the population, Banfield (1949) states that the increase was not steady, citing a severe winter kill in 1935–36 as evidence.

Further estimates were not made until 1941, when between 5000 and 7000 wapiti were believed present (Banfield 1949). Banfield estimated that the population continued to increase to 12000 in 1946, and eventually peaked at approximately 16800 in the fall of 1946. Harsh winter conditions in 1946–47, and habitat deterioration caused by several successive years

of over-browsing resulted in a dramatic decline in wapiti numbers during the late 1940s.

The moose population of Riding Mountain National Park has not been as closely monitored. Remnants of an indigenous population were probably present throughout the history of the area, but early accounts make infrequent mention of this species (Green 1933). No actual estimates of the moose numbers were made prior to 1950.

Therefore, I have summarized wapiti and moose population trends between 1950 and 1976. Aerial surveys have been conducted in 17 of the last 27 winter seasons by the Canadian Wildlife Service (CWS), park personnel under the direction of CWS, or the author. All estimates made prior to 1950 were based on ground observations. Wapiti population estimates made between 1950 and 1963 have been reviewed by Blood (1966, p. 39).

Study Area

Riding Mountain National Park is a 297 746-ha preserve located approximately 100 km north of Brandon in western Manitoba. The climate is typified by short warm summers and long cold winters. The park's location between the sub-humid boreal forest to the north and east and the semi-arid cool steppe to the south and west results in annual weather patterns which best typify one or the other of these basic climatic regimes. Extreme seasonal temperatures and variability in annual precipitation are characteristic.

Attendant vegetation reflects the transition of climates. Twelve basic cover types were recognized by Bailey (1967), and the predominant forest has been variously classified as parkland (Bird 1961) and savanna (Dansereau 1957). Aspen (*Populus tremuloides*) and mixed aspen–white spruce (*Picea glauca*) forests occupy approximately 70% of the area. Grasslands, shrublands, and several coniferous formations account for most of the remaining vegetation. Areas burned by wildfires occupy 10% of the land and are in various stages of succession.

The eastern and northeastern sections of the park are dominated by the Manitoba Escarpment, a sedimentary formation rising abruptly to 600 m above lowlands to the east and north. From the escarpment westward, the land is a gently rolling plateau sloping downward to the west where it blends imperceptibly into the prairies. End moraines characterized by hilly topography are common in the southern portions of the park. Drainage to the north and east is well-integrated (Nelson River system) while that to the south and west is poorly integrated (Assiniboine River system). Most of the area is overlain by glacial till (Ehrlich 1957).

An outstanding feature of the park ecosystem is its isolation in an agricultural region. Ingress and egress of wapiti and moose is common along park boundaries, but contact with other herds is infrequent. The herds, therefore, are not truly migratory, although seasonal shifts are evident within and adjacent to the park. Hunting occurs periodically on the private lands surrounding the park.

Methods

Population estimates since 1950 are based on aerial surveys using fixed-wing aircraft on north–south transects. Survey techniques, however, varied considerably through time. The number of transects flown ranged from 16 to 68, flying height from 30 to 125 m, and strip width from 0.4 to 0.8 km. Resulting coverage varied from 6.2 to 25% of the surface area of the park. Sixty-eight north–south transects spaced at 1-mi (1.6-km) intervals cover the east–west dimensions of the park. All surveys were conducted in January, February, or March, with the exception of November in 1959.

Variations in survey technique probably result

in significant differences in accuracy of population estimation. It is impossible, however, to determine the validity of any given survey, although insight is often gained from secondary sources and subsequent estimates. Population appraisals, therefore, are believed to reveal trends rather than absolutes. Insight into the accuracy of estimation will be given where appropriate.

Results

Fluctuations in the Wapiti Population

After the decline in numbers from the estimated high of 16 800 in 1946, the wapiti herd stabilized at about 4500 animals between 1950 and 1952 (Figure 1). A harvest of 938 wapiti in winter 1951–52 would account for a major part of the stabilization, and an additional kill of 1766 animals in 1952–53 aided a population decline to 2500.

The estimate of 1132 wapiti in 1955 is believed to be invalid as the survey report states that ground conditions were poor for sighting animals. A count conducted under good conditions in 1956 resulted in an estimate of 5200 wapiti, which further invalidates the previous estimate. The population subsequently declined to 2500 in 1957, showed a slight increase in 1958, and expanded rapidly in 1959 and 1960. Apparent range deterioration and extensive depredation on private lands surrounding the park resulted in a re-opening of hunting around the park and a planned reduction of the number of animals within the park. In total, more than 2500 wapiti were harvested and the population was reduced to approximately 2500 animals after the peak population in 1960 (Figure 1).

In the decade from 1950 to 1960, therefore, rapid changes occurred in the numbers of wapiti. Three peak populations of between 4000 and 5000 animals were recorded at the beginning, during the middle, and at the end of the decade. Estimates would indicate that population lows during the period were approximately 2500.

Only three aerial surveys were conducted during the 1960s (Figure 1). The population appears to have recovered slowly after the heavy kill of 1960, as only 2000 wapiti were reported in 1963 and 2364 in 1966. A rapid expansion was evident in the late 1960s, and a population of more than 5000 was estimated by the end of the

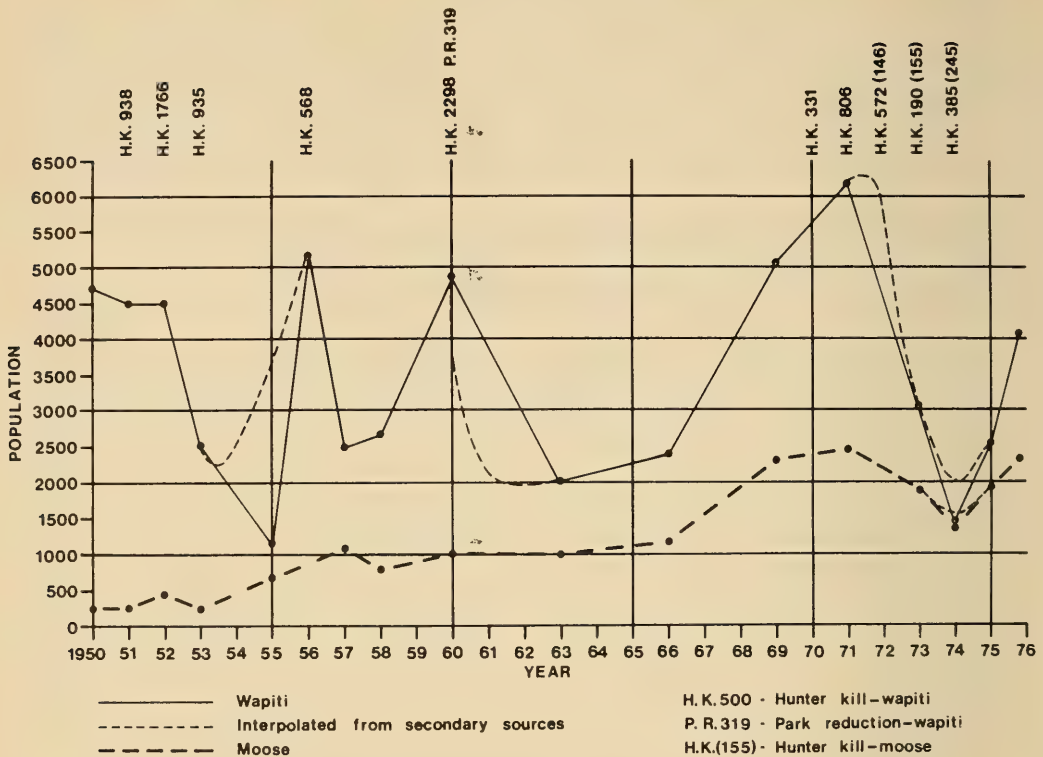


FIGURE 1. Trends in the wapiti and moose populations of Riding Mountain National Park, 1950–1976.

decade.

The span of 3-year intervals between surveys could be sufficient to hide an oscillation during the middle of the decade. Field reports in 1964, however, indicated that wapiti numbers had not increased greatly and normal increments in 1964 and 1965 would not be sufficient to reach former peaks of 4500 or more animals. Any fluctuation which may have occurred, therefore, probably did not approach the magnitude of previous changes.

A rapid increase in numbers during the late 1960s is documented in field reports submitted by wardens. Egress and depredation on private lands reflected the increase by 1968 and hunting seasons were re-instituted in 1970 to help alleviate the situation.

The highest estimated wapiti population since the mid-1940s was reached in 1971 when 6172 animals were reported (Figure 1). A subsequent survey in 1973 showed a rapid decrease in

numbers. Extensive field records during this period indicate that the population remained high in 1972, and subsequently decreased (Rounds 1976, unpublished report, Parks Canada). Further decline was evident in 1974 although the actual estimate is believed to be low because of a change in survey techniques. A rapid recovery was evident between 1974 and 1976.

Fluctuations in the Moose Population

Moose numbers were relatively low during early survey years but a noticeable increase occurred during the mid-to-late 1950s (Figure 1). The population remained near 1000 animals for 10 years (1957–1967). A slight increase was noticed between 1963 and 1966, and major herd expansion occurred between 1966 and 1969.

Moose numbers continued to increase until 1971, when a high of 2448 animals was estimated. Subsequent population decline was

evident from 1971 to 1974, when 1348 animals were estimated. The latter figure, however, may be an underestimate because of survey techniques employed (Rounds 1976, unpublished report, Parks Canada). The herd again expanded in 1975 and 1976.

Summary and Discussion

It is apparent that wapiti and moose populations in Riding Mountain National Park have had distinct patterns of change through time. Wapiti show rapid changes in number during the last 25 years, with four population lows of approximately 2000 animals and four peaks of between 4500 and 6000 animals. The population appears to be somewhat cyclic, although the timing of the cycles is uneven and hunting has on some occasions accounted for most of the observed declines. The fact, however, that hunting mortality does not account entirely for several declines indicates that fluctuations have natural causative factors. If a minor peak had been reached in 1965 (speculative), the high populations would occur approximately every 5 years. Such population oscillations are characteristic of ungulates (Moen 1973).

Trends in the number of moose show a different growth pattern. Between 1950 and 1970, the herd increased, but the rate of increase was not consistent. A curvilinear representation for the 20-year period, however, indicates a slow geometric increase. The oscillation that has occurred during the last 5 years suggests that continuous herd expansion has ceased and further oscillation may be expected. Hunting mortality of moose between 1971 and 1974 is not sufficient to account for the overall decline.

The best tentative explanation of the observed patterns of change is that of progressive habitat stabilization since the wapiti reached maximum numbers in the mid-1940s. Commercial logging was widespread until that time and resulting seral communities provided excellent habitat for wapiti, which eventually resulted in excessive numbers of this species (Banfield 1949). Following curtailment of timber-cutting and the rapid decrease of the wapiti population in 1946-47 (Banfield 1949), seral communities began to mature. The moose population, free from overbearing competition, increased slowly while the wapiti population began to fluctuate.

During the first 15 years of record (1950-1965) the two populations appear to be independent as fluctuations in wapiti numbers and increases in the number of moose show no apparent relationship. But since 1965, the two ungulate populations show coordinated patterns of increase and decrease. This latter pattern may suggest either independent habitat limitations (carrying capacities) or stabilization of inter-specific relationships. The fact that recent population trends coincide temporally suggests the latter of these alternatives.

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Growth Rates in Vegetative and Reproductive Tissue of *Parmelia cumberlandia* after Relocation to a New Environment

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Abstract. A large colony of the lichen *Parmelia cumberlandia* (Gyeln.) Hale and its rock substrate were subdivided by means of a diamond saw and the portions relocated at different sites. After 1 year, vegetative growth and trends in the production of apothecial tissue were observed. The annual growth rates recorded for the vegetative part of the thallus of *P. cumberlandia* were considerably higher than for any other species of *Parmelia* reported previously and are among the highest reported for any lichen. In sections of the thallus transported to new and slightly more southerly locations, previously existing apothecia expanded to a greater extent, and new apothecia developed more frequently, than in the control location.

The slow growth rate of lichen thalli has been widely studied and appreciated. Growth is influenced by various environmental factors through their effect on the rate of assimilation. Hale (1973) has reviewed the literature concerning individual environmental factors which are known to modify the rate of thallus growth; e.g., moisture is important, particularly the mean amount of rainfall per day. Temperature also affects growth rates, as does nutrient availability.

The rate of expansion of sexual reproductive tissue, apart from the vegetative thallus, has never been documented; whether modifications to the environment affect the growth of reproductive structures is not known. The aims of this study were to determine the rate of apothecial growth during a 1-year period, and to compare the trends of apothecial expansion in thallus segments which have been placed during this time at different sites within the normal geographic range of the lichen.

Parmelia cumberlandia was chosen for this study because its large thalli can be subdivided into comparable sections of sufficient size to make adequate sampling possible within each. Another advantage is that *P. cumberlandia* as a saxicolous lichen can be conveniently transplanted while attached to its normal substrate, thus avoiding re-establishment problems in the new site.

Materials and Methods

Lichen material was obtained near Collingwood, Ontario in June 1973. It was identified by M. E. Hale as *Parmelia cumberlandia* (Gyeln.) Hale, and voucher specimens were deposited in the lichen herbarium of the University of Western Ontario. The main secondary compounds were identified using the method of Culberson (1972) as stictic acid and norstictic acid, with constictic and usnic acids as minor components. The same compounds were present before and after the transplantation. A single rock covered on one face by a large orbicular lichen colony was subdivided by the use of a diamond saw. During the cutting operation, cooling was accomplished by directing a steady stream of 20°C distilled water over the blade.

Cut segments were deposited early in June at three sites in Ontario (Table 1, Figure 1) where they remained for a period of 12 months. All sites were within range of *P. cumberlandia* but no individuals were growing at either southern site prior to the beginning of the experiment. There were basic similarities among all three sites, but the Collingwood area had more snowfall during the year and colder mean temperature both summer and winter. Part of the experimental lichen material was returned to its original habitat near Collingwood, a grassy meadow on a south-facing slope. Niagara Falls had the lowest total snowfall and warmest

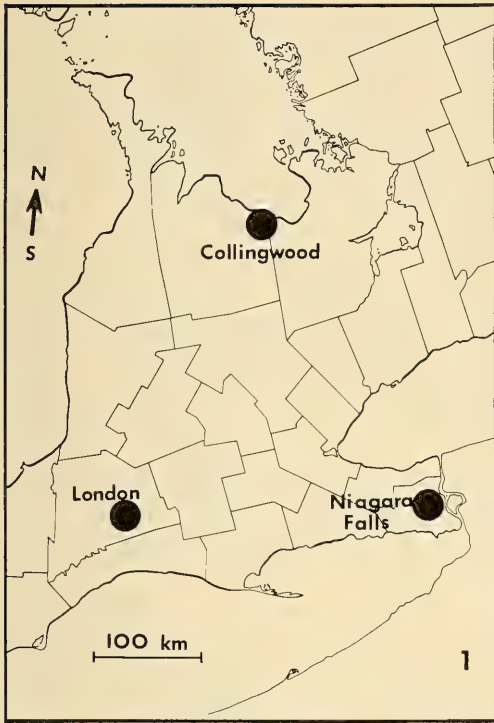


FIGURE 1. Map of southern Ontario showing the transplant localities.

temperatures year round; here the lichens were placed in a grassy field. London was intermediate, in many respects, to the other two sites; the lichen material here was allowed to grow in a south-easterly sloping meadow. All sites had the same total amount of precipitation during the year but seasonal distribution of moisture was different in each. The climatic regimes differed generally from each other, especially as regards winter maximum and minimum temperatures (Table 1).

A photographic record was made of each thallus segment, first prior to transplantation and again after 1 year had elapsed. In each case, photos were made after thalli had been air-dried at room temperature for 3 days. The amount of vegetative growth (increase in lobe length) and trends in apothecia production were recorded at each site. For determining the linear growth rate of marginal lobes, six measurements were made per treatment. Otherwise, three replicates were used throughout.

The image of the thallus (Figure 2) was projected from a 35-mm transparency onto a screen where it was enlarged to 10× the actual size of the lichen. Outlines of pre-transplantation thallus margins were traced onto squared graph paper tacked temporarily to the projection screen. The extension of lobes was

TABLE 1—Meterological conditions June 1973 to June 1974 in three areas of southern Ontario where clonal material of *P. cumberlandia* was grown^a

	Location		
	Collingwood	London	Niagara Falls
Total snowfall (cm)	272	190	157
Total days with measurable snow	37	65	39
Total precipitation (cm)	102	103	102
Month with highest precipitation	Dec.	Mar.	Aug.
Mean daily maximum temperature, July (°C)	23.7	25.7	26.8
Mean daily minimum temperature, July (°C)	13.1	14.2	16.8
Mean daily mean temperature, July (°C)	18.4	19.9	21.8
Mean daily maximum temperature, Jan. (°C)	-0.7	-0.5	1.0
Mean daily minimum temperature, Jan. (°C)	-7.9	-8.1	-5.8
Mean daily mean temperature, Jan. (°C)	-4.3	-4.3	-2.4
Total days without freezing	218	221	237
Mean annual growing degree-days ^b	3000	3600	4000

^aFrom *Monthly record-meterological observations in Canada*, Environment Canada.

^bAverage based on approximately 40 years of records (Brown et al. 1968).

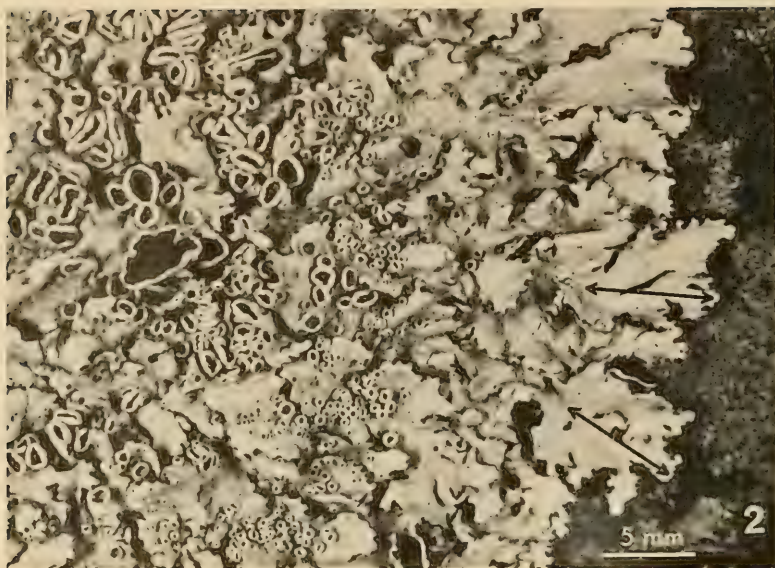


FIGURE 2. Thallus of *Parmelia cumberlandia* after transplantation. Material near the margin, shown by the length of arrows, was produced between June 1973 and June 1974.



FIGURE 3. Surface of the *Parmelia cumberlandia* thallus showing two young apothecia, one of which has only recently differentiated from the vegetative thallus. Plant material was coated 30 to 40 μm in thickness with vapors from a block of gold palladium and then examined under a Cambridge Mark IIa Stereoscan scanning electron microscope.

determined by superimposing the image of the post-transplantation lichen. In order to obtain an estimate of the radial rate of thallus expansion, marginal lobes at regular intervals along the edge of the post-transplantation thallus were selected. By comparison to the pre-transplantation thallus the direction of growth was determined and the annual increment measured and converted to growth in millimetres per year.

Changes in reproductive structures were measured in quadrats 6.3×6.3 cm, on the enlargement of the pre-transplantation lichen. The quadrats on the enlarged thallus corresponded to an actual size of 6.3×6.3 mm on the thallus, and were recognizable after 1 year by virtue of the position of key apothecial and vegetative features. Three series of quadrats were used; these were centered equidistantly, i.e., 11, 18, and 25 cm from the margin on the enlarged thallus image (young, medium-aged, and older series, respectively). The first plot in each series was selected randomly and the others were spaced systematically in relation to the first. Outlines of apothecia in each quadrat were drawn on graph paper, and post-transplantation thallus outlines were superimposed on the tracings of the pre-transplantation lichen. The apothecial areas were determined from these 6.3×6.3 cm tracings. Coverages were then converted to square millimetres of apothecia/100 mm² of thallus surface; growth rates were expressed as square millimetres of new apothecial tissue/100 mm² of thallus area/year. The amount of new apothecial tissue formed and the amount of apothecial area which was lost during the course of a year were both determined. The net difference in ascocarp area was recorded, and changes in the numbers of apothecia were monitored as well.

Results and Discussion

Use of a diamond saw to subdivide saxicolous lichens is a recommended technique, as there was very little apparent damage to the thallus; *P. cumberlandia* thallus segments were able afterwards to undergo both vegetative and reproductive growth. Some aspects of normal physiological activity (e.g., assimilation) were thus being maintained.

Thallus expansion occurred at the margins in all of the transplanted segments with no significant difference (at the $P \leq 0.05$ level, unpaired *t*-test) between the control and the other two sections. The average increment in length of lobes at the control location was 7.6 mm per year; at London and Niagara Falls, the average increments were 6.8 and 6.2 mm per year, respectively. The average growth rate measured in other *Parmelia* species has been in the range of 1 to 2 mm per year (e.g., Hale 1954, 1959; Brodo 1965). The rates observed in the present study are among the highest reported for any foliose lichen. This is somewhat surprising in view of the fact that the thallus was a large one with an approximate diameter of 12 cm. The rate of growth is generally less for larger and older lichens than it is for smaller and younger ones (e.g., Armstrong 1973). Apparently, despite its large size, the thallus used in this study was still vigorously assimilating and had not yet reached the senescent stages. Different species grow at widely different rates; *Parmelia cumberlandia* may simply be one of the faster ones. Similar high growth rates were recorded by Phillips (1969) in two species of *Lobaria*. He observed average annual radial growth rates of 4.8 and 6.5 mm, but single lobes averaged as high as 8.6 mm per year. In *Parmelia isidiosa* (= *P. conspersa*) Phillips (1963) found increases averaging 5.3 mm per year (range 4.5 to 8.2 mm per year). Hale (1970) has suggested that the mild winters of Tennessee, as opposed to those in the northern United States, might be responsible for the rapid growth rates reported by Phillips. In view of these findings, it would be interesting to measure the growth rate of *Parmelia conspersa* in southern Ontario and that of *P. cumberlandia* in Tennessee.

The more peripheral or distal part of the thallus was considered to be younger, and the tissue toward the center progressively more mature. At the control site (Collingwood), new apothecial tissue was formed during the course of the year in all the quadrats. Quadrats in the younger and middle-aged series, however, produced by far the greatest amounts.

In the younger parts studied (plots centered 11 cm from the margin of the enlarged thallus), all of the ascocarps which were present at the beginning of the experimental period were still

intact at the end and most had expanded in size. In the older thallus parts (quadrats centered 25 cm from the margin on the enlarged image), approximately three-quarters of the previously existing apothecial area had atrophied and disintegrated after 1 year. The remains could sometimes be identified in photographs. In older quadrats, there was more attrition of sporing structures than new growth.

The rate of expansion of apothecial tissue depends, therefore, on which portion of the lichen is being considered. At the control site, the annual increase in apothecial area in the younger portions of the thallus was $7.8 \text{ mm}^2/100 \text{ mm}^2$ of thallus (Table 2). This increase was mainly due to the expansion of pre-existing reproductive structures (about 75%) and partly to growth of newly formed apothecia (about 25%). In older tissue, the gain in new apothecial area during the course of 1 year was only $4.8 \text{ mm}^2/100 \text{ mm}^2$ of thallus.

Lichen segments transplanted to the London area showed no significant differences from the control in the rates at which apothecial tissue atrophied (Table 2). In the younger and medium-aged plots, however, a significant increase in the rate of expansion of apothecia was observed. The absolute increments in London were three times as much as in

Collingwood; the increase at London corresponded to a 13-fold expansion, while at Collingwood, the new apothecial area produced in the younger series of quadrats represented only a $2\frac{1}{2}$ -fold increase over what had been present at the beginning of the experiment. The remarkable expansion of apothecial area in the more marginal quadrats at the London site was about 40% derived from growth of apothecia which existed previously and 60% due to new apothecia which developed during the 1-year period of the experiment. The number of new apothecia formed in the younger parts of the lichen growing in London was also significantly greater than in the control (Table 3, Figure 3). Perhaps the milder growing conditions (Table 1) at London were responsible for increased initiation of new apothecia in marginal areas and of increased growth of previously existing ones.

Thallus segments transplanted to Niagara Falls showed no significant differences from the control as far as changes in apothecial area were concerned (Table 2). The increase in apothecial area was about the same as in the Collingwood material. The middle-aged tissue at the Niagara Falls site, however, produced a significantly larger number of new apothecia than the control (Table 3) although each remained relatively small, and in the older tissue fewer apothecia

TABLE 2—Changes in apothecial tissue of *Parmelia cumberlandia* from June 1973 to June 1974. Apothecial areas are presented as $\text{mm}^2/100 \text{ mm}^2$ of thallus surface^a (Percentage of change over pre-existing apothecial area is also given)

	Relative age of tissue ^b	Site					
		Collingwood (control)		London		Niagara Falls	
		Area	%	Area	%	Area	%
Gain in new apothecial area	Y	7.8	256	23.4*	1370	4.8	117
	M	9.1	66	26.4*	175	5.8	74
	O	4.3	21	18.9	106	3.3	41
Loss of original apothecial area	Y	0.0	0	0.0	0	0.3	8
	M	5.0	36	0.3	20	1.3	17
	O	16.9	81	14.9	84	4.0	50
Net change in apothecial area ^c	Y	7.8	256	23.4*	1370	4.5	100
	M	4.0	29	26.1*	155	4.5	56
	O	-12.6	-60	4.0	23	-0.7	9

^aValues shown are means of three replicates. Figures which differ significantly from the control at the $P \leq 0.05$ level are indicated with an asterisk (unpaired *t*-test).

^bY = young, M = medium age, O = old.

^cA minus sign indicates a net loss in apothecial area.

TABLE 3—Changes in the average number of apothecia per 100 mm² of thallus surface^a

Site	Relative age of tissue											
	Young				Medium				Old			
	Initially	Gained	Lost	Net change	Initially	Gained	Lost	Net change ^b	Initially	Gained	Lost	Net change ^b
Collingwood (control)	9.7	6.0	5.3	0.7	11.0	3.3	8.0	-4.7	17.7	3.7	11.0	-7.3
London	12.7	11.7*	8.3	3.4	13.7	7.3	6.7	0.6	14.7	7.0	12.0	-5.0
Niagara Falls	8.7	3.3	1.3	2.0	11.3	16.7*	3.3	13.4	10.3	5.0	6.0*	-1.0

^aValues are the means of three replicates. Figures which differ significantly from the control at the $P \leq 0.05$ level are indicated with an asterisk (unpaired *t*-test).

^bA minus sign indicates a net loss of apothecia.

became senescent. Niagara Falls had the highest mean daily maximum and lowest mean daily minimum temperatures in both January and July as well as the least snowfall and the most days without freezing. These conditions were even milder than those in London, and may be the explanation for the larger numbers of apothecia which were initiated.

Increased production of new apothecia at the London site took place mainly in marginal areas, while at Niagara Falls, the increase in apothecial initiation was observed in medium-aged thallus parts. Perhaps the age of thallus tissue which readily initiates apothecia varies with the mildness of the climate. Another possibility is that the annual distribution of precipitation may be important to apothecial initiation; in London, a larger proportion of the rainfall occurs in spring months, but in Niagara Falls the greatest monthly precipitation is in August.

The quality of air in the two southern locations may have been different from that in the control area. But the London site was just north of the city limits on the west end of the city, an area which has high lichen diversity; i.e., a number of city-sensitive species grow there which do not exist in more industrial east London or downtown (Roze 1973, unpublished data). The Niagara Falls site was near Buffalo, New York, but upwind from it and in a semi-rural residential area. It was considered possible, but unprovable, that air-borne pollutants could have been causal factors in the change of apothecial production patterns.

Although one cannot from these data reliably state which environmental factors cause the observed changes, it does appear that the magnitude of environmental differences within the normal range of a given lichen is sufficient to

modify both initiation and growth of structures concerned with sexual reproduction. In slightly more southern locations, a greater amount of the available resources seems to be channelled into reproductive growth. Sexual reproduction in *Parmelia cumberlandia* may be more affordable where winter growing conditions, for example, are less severe.

It should be pointed out that the present study was based on a single large thallus (this was done in an attempt to minimize genetic variability within the experimental material). It is conceivable, though perhaps unlikely, that physiological differences among portions of the particular thallus chosen were responsible for the observed differences in apothecial initiation. In addition, it is possible that ascogonial initials were formed prior to the beginning of the experiment, but this seems unlikely in view of the experimental results.

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Aspects of Woodcock Nocturnal Activity in Southwestern Quebec

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Abstract. Information was obtained on the nocturnal behavior of American Woodcock (*Philohela minor*) in southwestern Quebec. Initiation of evening activity was governed by light intensity. Timing of flights fluctuated in relation to sunset as length of twilight changed, and also tended to vary with cloud cover. Spring courtship in the evening averaged 46 ± 13.0 min and was longer than that reported for southern latitudes. This difference may be related to the shorter duration of twilight further south. In August, a reduction of flight activity occurred concurrent to the period of feather molt. An increase in activity thereafter was partially due to an influx of birds. Sand transect data showed woodcock were active at night for short periods around crepuscular flight times. Evening activity in fields may have resulted from birds searching out preferred sites. Activity in the morning may have been due to foraging prior to departure to diurnal habitat. Inactivity for most of the night indicates that woodcock use fields as roosting areas.

The biology of the American Woodcock (*Philohela minor*) has been reviewed by Sheldon (1967). Characteristically the species is an early spring migrant to its breeding grounds in the northeastern United States and adjacent Canada. Males probably arrive first to establish their courtship territories (singing grounds), usually in shrubby fields. They fly to these areas each evening from forested cover and perform courtship activities there for short periods after sunset and before sunrise. Females are attracted to the singing grounds where copulation takes place. Once the breeding season ends, in early June, territorial aggression ceases. For the remainder of the year, until autumn migration, birds of all sex and age classes congregate on these fields at night and continue to use nearby coverts during the day.

In this study we attempted to document woodcock behavior and activity patterns during their period of stay in Quebec. Light intensity is an important proximate timer for woodcock movements (see Duke 1966). We hypothesized, therefore, that because of changing light conditions with latitude, important features of woodcock biology differ between extreme northern and southern parts of the breeding range.

Since Sheldon's (1961) observation that woodcock continue to use fields at night after the end of the breeding season there has been speculation about what functions these open

areas serve (Dunford and Owen 1973). To understand better the importance of this habitat we attempted to measure the extent of its use over the season and the temporal activity patterns of woodcock using fields on individual nights.

Study Area

The 1.6-km² study area is located in the Laurentian Uplands of Terrebonne County, Quebec (46°09' N, 74°29' W) 23 km northwest of Ste Agathe. The glaciated hilly terrain supporting a mixture of shrubby fields, seral patches of deciduous and coniferous woods, and blocks of mature deciduous and mixed forest has been described by Bider (1968) and Wishart and Bider (1976).

Methods

Between 20 April and 5 November 1972 we recorded observations of woodcock evening activity. The position of observation was taken 20 min before predicted initiation of movements between diurnal and nocturnal habitat. Behavior of birds seen or heard in flight to fields was described and the time noted. Weather conditions were recorded at a meteorological station at the study area.

Although territories were defended only until early June, some woodcock courtship displays occurred sporadically throughout the summer and autumn. The incidence of this behavior was

noted and it provided an index of evening activity.

We erected mist nets each evening on different fields in the area and occasionally left them open until woodcock had departed the next morning. One mist net operated for either the evening or morning activity period was counted as 1 net night. The number of woodcock captured per net night during the post-breeding period provided an index of activity on fields. All captured birds were aged (Martin 1964), sexed (Greeley 1953), banded with numbered aluminum leg bands, and individually marked with colored nape tags similar to those used by Nelson (1955).

To provide an index of woodcock density in the area we made regular systematic searches of diurnal habitat. Each bird flushed and any sign (droppings, probe-holes, footprints, and feathers) observed was counted and expressed per hour of search time (see Wishart and Bider 1976).

The nocturnal activity of woodcock in fields was measured at the study area in August and September of 1967 and 1968 by the sand transect technique (Bider 1968). This method allowed remote census of the population without requiring the use of radio transmitter-equipped birds. The transect, 238.7 m in circumference and 0.6 m wide, was situated in a field used by woodcock at night. Woodcock crossings in the sand were recorded and then erased every 2 h of each day. Data showed when and where birds

were active and the number of crossings indicated the intensity of activity.

Results

Flight Initiation

Eighteen shrubby openings on the study area were used by woodcock as courtship territories and 19 such openings were frequented at night after the breakdown of territoriality. The initiation of evening flights changed in relation to sunset over the season (Figure 1, Table 1). Spring (21 April–10 June) and autumn (10 September–28 October) flights began at about the same time-lag after sunset ($P > 0.05$; *t*-test); however, summer (11 June–9 September) flight initiation was significantly later than in either the spring ($P < 0.01$; *t*-test) or autumn ($P < 0.05$; *t*-test). Flights tended to begin earlier in relation to sunset on overcast compared to clear evenings ($P > 0.05$; *t*-test) (Table 1).

Duration of Activity

During the breeding season, when displaying birds were in the air, it was difficult to determine the duration of evening flights from woods to fields. In the post-breeding period this was more easily done. On 46 evenings, when more than one woodcock was observed in the air, the period of flight activity for the population lasted 1–15 min and averaged 6.1 ± 3.5 min (Table 1). Length of flight activity did not differ significantly ($P > 0.05$; *t*-test) over the season or under varying cloud conditions, although flights were of slightly longer duration on clear evenings.

TABLE 1—Initiation and duration of woodcock flight activity in relation to cloud cover and season

Dates	Flight initiation after sunset (minutes)		Duration of evening flight ¹ (minutes)	
	Overcast ²	Clear ³	Overcast	Clear
21 April–10 June	17.8 ± 11.0 (N = 8) ⁴	25.9 ± 11.3 (N = 13)		
11 June–9 September	31.6 ± 12.7 (N = 20)	36.7 ± 6.7 (N = 21)	5.2 ± 3.3 (N = 9)	6.4 ± 4.1 (N = 14)
10 September–28 October	22.0 ± 7.8 (N = 15)	29.1 ± 5.4 (N = 13)	5.2 ± 2.3 (N = 10)	8.0 ± 4.3 (N = 8)

¹When more than one woodcock was observed per evening.

²0.75 to full cloud cover.

³0.0 to 0.25 cloud cover.

⁴Number of evening flight periods in sample.

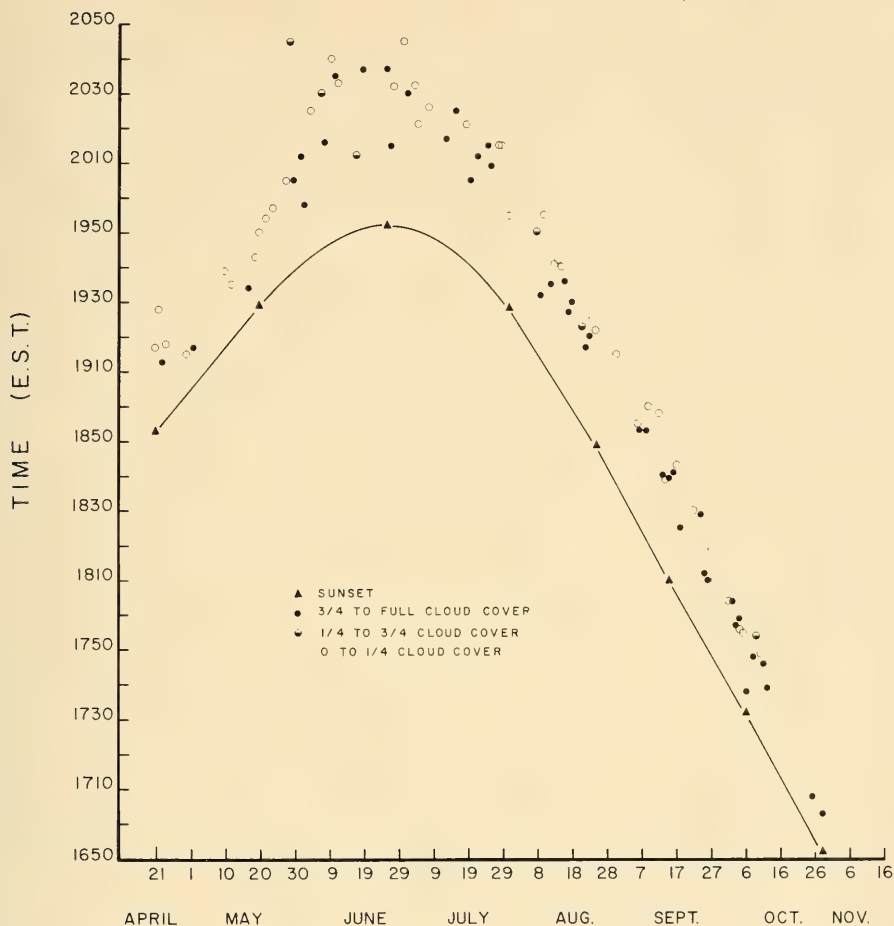


FIGURE 1. Seasonal relationships of woodcock flight initiation to sunset and cloud cover.

Between 20 April and 4 June male woodcock performed courtship displays each evening, characterized by vocalizations (*peents*) on the ground, interspersed with aerial displays over the territory (Mendall and Aldous 1943). From first to last *peent* each evening, courtship lasted for 46.2 ± 13.0 min (13 evenings). Sporadic *peenting* continued, however, on bright moonlit nights.

Seasonal Changes in Flight Activity

After 10 June, nightly counts were made of the number of woodcock seen and heard flying to openings from diurnal coverts. To avoid

duplication, those performing protracted courtship were not included. This index of activity showed that a distinct seasonal pattern occurred. Groups of values (Figure 2) were compared using the Mann-Whitney U test to detect the significance of changes.

The summer peak in flight activity occurred between 27 June and 19 July. A significant decrease ($P < 0.05$) followed until 13 September, which was in turn followed by an increase ($P < 0.01$) that lasted until 6 October. Activity decreased thereafter and declined to zero by 29 October.

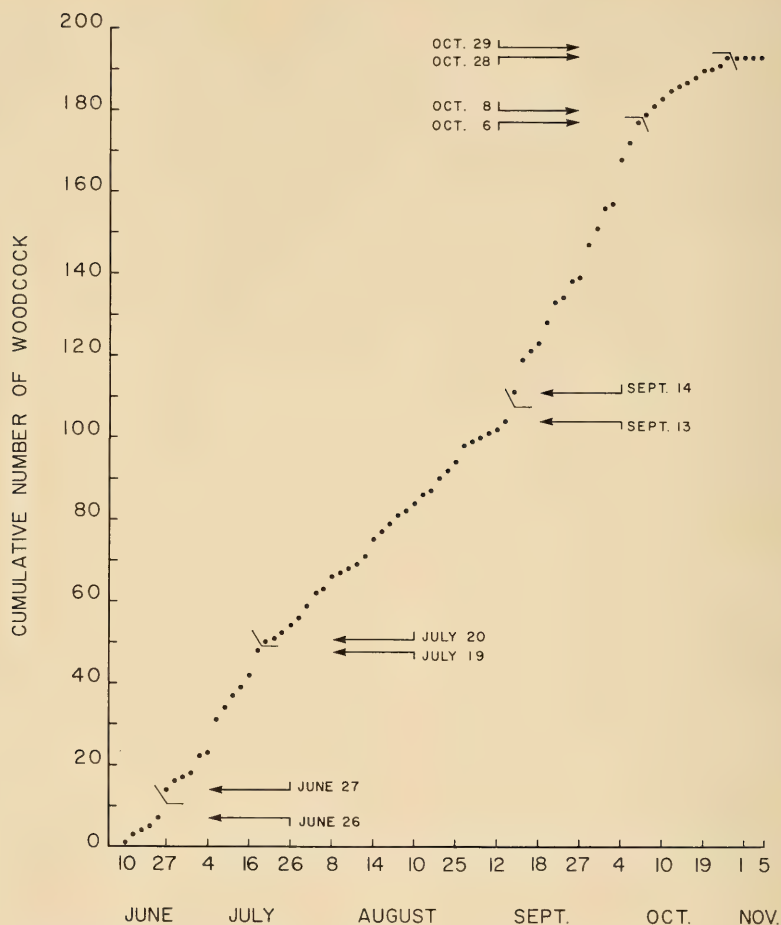


FIGURE 2. Cumulative frequency curve showing the number of woodcock flying to nocturnal fields each evening over the season. Arrows indicate the dates at which slopes change.

The incidence of protracted courtship and mist-netting success similarly indicated a drop in woodcock activity in August followed by an increase before autumn migration. In June and July, courtship was heard on 21% of observed evenings (24 evenings) and in September and October this rose to 39% (34 evenings). In August, however, the incidence of protracted courtship was low (6% of 16 evenings). Mist-netting success also declined to a low of 0.4 captures per mist-net night during August (Figure 3).

Diurnal habitat surveys were used as an index

of woodcock density in the area and provided a means of determining what factors affected changes in flight activity. Between the spring and summer, surveys showed the woodcock population changed little ($P > 0.05$; chi-square test) in size. But after mid-September, a significant ($P < 0.01$; chi-square test) increase occurred. After 1 November, few woodcock remained in the area and none was flushed from previously occupied coverts in 174 min of survey (Table 2).

Nocturnal Activity in Fields

The sand transect, read over 26 days, yielded

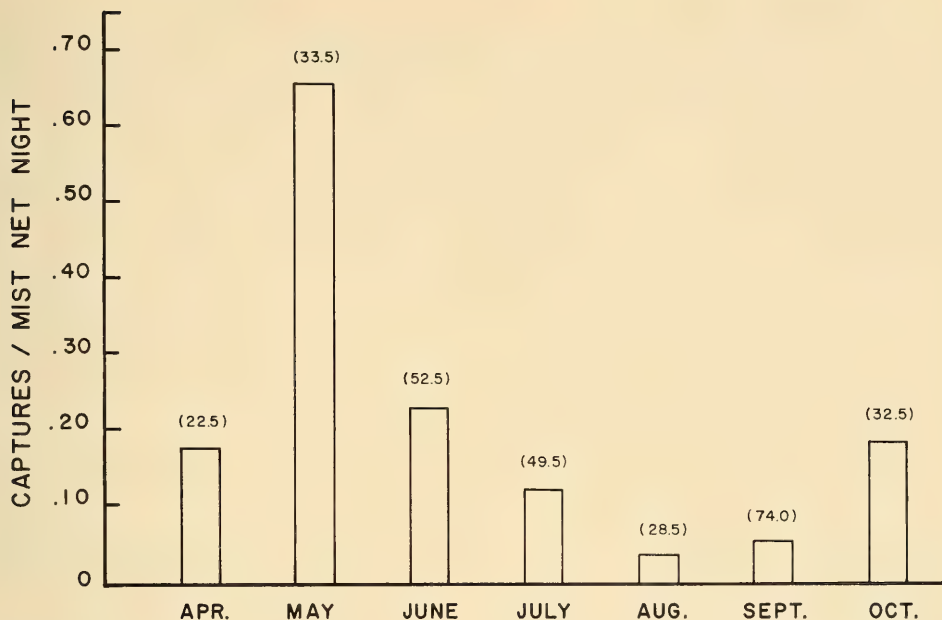


FIGURE 3. Number of woodcock captured per mist-net night over the season. Numbers in brackets indicate the number of mist-net nights recorded per month. High values in April and May are due to the site tenacity of territorial males.

86 woodcock crossings. Distinct crepuscular peaks of activity occurred within 1 h of the estimated periods that woodcock entered and departed from fields at that time of year. No crossings were recorded before 1800, between 2100 and 0400, or after 0600 hours Eastern Standard Time. Evening activity (76 crossings) was 7.6 times greater than that in the morning (10 crossings).

TABLE 2—Woodcock flush and sign surveys in diurnal habitat indicating seasonal changes in density

Dates	Hours of survey	Woodcock flushed per hour	Woodcock sign per hour
20 April–10 June	36.9	0.7	8.9
11 June–9 September	36.0	1.0	9.0
10 September–1 November	15.8	2.0	28.5

Discussion

The timing of evening flights from diurnal to nocturnal cover changed over the season. Therefore, it seems that flight initiation is governed by a critical light intensity (Duke 1966) which is altered over the year in its time of occurrence because of the change in rate of the sun's descent. The duration of twilight varies with the constant change in position of the earth in relation to the sun (McGraw-Hill Almanac 1969). The slower descent of the sun in June and July, therefore, is likely the reason for the skewed nature of Figure 1. Leopold (*in* Welty 1962) observed a similar pattern of commencement times of morning song by several species.

Greater cloud cover tended to be correlated with earlier flight initiation, but the relationship was not significant ($0.1 > P > 0.05$; *t*-test). Thus, although woodcock did respond to seasonal changes in light conditions, day-to-day variations caused by cloud were not enough to elicit a large response. In Maine, Krohn (1971) observed a similar relationship.

Evening courtship displays averaged about 46 min, which agrees with findings by Duke (1966) studying woodcock at a similar latitude. In Maryland, however, Sheldon (1967) found courtship lasted for only 20 min and concluded that birds in northern areas perform longer. Miller (1958), studying the American Robin (*Turdus migratorius*), reported similar findings concerning length of morning song. This relationship suggests that latitudinal differences of crepuscular light conditions are responsible for the observed variability. As one moves southward on a given day (in the spring) there is an increase in the rate of the sun's descent at night and ascent in the morning (McGraw-Hill Almanac 1969). Thus, the length of time each day with light intensities typical during woodcock courtship is shorter further south. It is not known if this variability of length of courtship affects woodcock productivity at various latitudes.

All three indices conclusively indicated a decline in flight activity of woodcock in August, followed by a rise in autumn (see also Sheldon 1961; Krohn 1971). Despite these changes in flight activity and recruitment of juveniles, diurnal habitat surveys showed the population was almost stable in size over the spring and summer. Autumn surveys, however, indicated an increase in the population, likely as a result of more northern migrants moving into the area. Therefore, at least part of the rise in activity after mid-September can be attributed to the rise in woodcock density. Flight activity declined after 8 October and reached zero on 29 October, indicating that migration from the area was completed.

Woodcock undergo a complete post-breeding molt and the nutritional demands of feather growth may be the reason for the mid-summer waning in activity. Heinroth and Heinroth (1958, p. 91) stated that when birds molt they are less active, energy being used to renew feathers. Payne (1972), reviewing the literature, indicated that metabolic rate of molting birds may increase up to 30% over that of non-molters.

Owen and Krohn (1973) found the peak of the woodcock molt in Maine occurred in August. Fat deposition was negatively correlated with the molt and they judged that most of these birds were physiologically unprepared for migration

until mid-October. Thus, the August decline in flight activity of woodcock is correlated with the peak of physiological stress due to molt. At this time a portion of the population seems to remain in forested habitat throughout the day and night. It is unknown if all individuals follow this pattern, at what stage of stress reduced activity occurs, and over what length of time it persists for an individual. Throughout the summer and autumn, birds of all sex and age classes were captured on fields at night, but data were insufficient to determine if a particular class was most responsible for the decline in activity.

Woodcock not participating in crepuscular flights and remaining in coverts at night would conserve energy. Earthworm surveys have shown that relatively few food items are found in summer fields (Wishart and Bider 1976) and little feeding occurs there (Krohn 1970). During the molt, birds may tend to remain in coverts where food is plentiful, and actively feed throughout the day and night there until a level of physical condition is re-attained.

Sand transect information showed that woodcock were inactive for most of the night after they had entered fields. Peaks of activity occurred within one hour of entrance and departure. Dunford and Owen (1973) and Owen and Morgan (1975), using birds equipped with radio transmitters, also found them sedentary for most of the night. Sheldon (1961) believed that woodcock flew to fields to feed, as occurs on the wintering grounds (Glasgow 1958). Krohn (1970), however, found that little food was obtained on summer fields, and Dunford and Owen (1973) speculated that they may act as roosting sites, providing security from predators. Unfortunately little is known about predation on woodcock, and the advantage to birds of roosting in open areas is not clear. Bider (1968) has shown that few potential woodcock predators consistently hunt in open fields.

At the study area, activity on fields took place soon after birds entered and just before morning departure. Krohn (1971) and Wishart and Bider (1976) observed that woodcock dispersal on summer fields was not random. If fields are indeed used for roosting, birds may have to search for sites with suitable microhabitat cover before settling for the night. This may require them to make several flights over the area, to

change fields a number of times, and to do some searching on the ground. Why then are birds also active prior to morning departure? Mendall and Aldous (1943) believed early morning and late evening were favorite feeding times for woodcock. Krohn (1970) pointed out that whereas little food was obtained on fields there was evidence that some foraging took place there. The morning surge in activity, therefore, may be due to foraging. The lack of success in finding sufficient food then might in part stimulate birds to return to diurnal habitat where both food and cover are more abundant.

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Reproductive Success of Herring Gulls Nesting on Brothers Island, Lake Ontario, in 1973

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Teeple, Stanley M. 1977. Reproductive success of Herring Gulls nesting on Brothers Island, Lake Ontario, in 1973. *Canadian Field-Naturalist* 91(2): 148-157.

Abstract. Breeding success and causes of breeding failure were assessed in 1973 in a Herring Gull colony of 34 pairs in eastern Lake Ontario. Breeding synchrony was normal, 13 pairs laid repeat clutches, but 77% of all eggs laid failed to hatch. The number of chicks fledged per pair averaged at least 0.06 but not more than 0.18, an exceptionally low result. Geometric mean concentrations of DDE and PCBs in 15 eggs that failed to hatch were 134 and 420 ppm dry weight. Concentrations of dieldrin, *p,p'*DDD, *p,p'*DDT, heptachlor epoxide, β -benzene hexachloride, hexachlorobenzene, and mercury were each less than 6 ppm. Arithmetic mean shell thickness of 13 of those 15 eggs was 0.339 mm, and mean thickness index of 11 of those 13 was 1.60; both are low values. Pathological examinations and analyses for organochlorine pesticides and PCBs in brains were conducted on 12 chicks that died. For 11 of the 12, no clear cause of death could be determined. A general association was established between high organochlorine levels and the low breeding success.

Studies by Keith (1966) and by Ludwig and Tomoff (1966) showed low breeding success and high organochlorine (OC) residue levels in populations of Herring Gulls (*Larus argentatus*) in Lake Michigan in the mid-1960s. Hickey and Anderson (1968) demonstrated a relationship between egg-shell thinning and levels of DDE in the eggs of five Herring Gull populations in eastern North America and later documented shell thinning in a number of North American bird populations, among them Herring Gulls on the Great Lakes (Anderson and Hickey 1972). They found that shell thinning in the Great Lakes population began in the late 1940s or early 1950s, and that during the period 1960-1969 shells were 10% thinner than in eggs collected prior to 1947. Gilbertson (1974) and Gilbertson and Hale (1974) also have shown that low breeding success coupled with thin-shelled eggs having high OC levels prevailed in Herring Gulls in the lower Great Lakes in 1972 and 1973.

This paper reports on the breeding success, shell thicknesses, and OC residue levels of non-hatching eggs and chicks that died in a small Herring Gull colony in eastern Lake Ontario in 1973, and provides further documentation of the low reproductive success of Herring Gulls nesting in Lake Ontario.

Study Area and Methods

"Brothers Island" (44° 12' N, 76° 39' W) is the most westerly of the three Brothers Islands in

eastern Lake Ontario, 13 km west of Kingston and about 1.3 km offshore, between Amherst Island and the mainland. Brothers Island is approximately 215 m long and varies from 1 to 10 m in width. Elevation was about 1 m above the lake level prevailing in the 1973 breeding season. The gulls nested on a flat area of limestone running most of the length of the island. Over its full length, trees, shrubs, and climbing vines were interspersed among relatively open areas bearing only ground vegetation. Tangles of vines, shrubs, and driftwood provided hiding places for gull chicks, as did crannies in the broken limestone. Except for three pairs of Mallards (*Anas platyrhynchos*) and a single pair each of Song Sparrows (*Melospiza melodia*) and Red-winged Blackbirds (*Agelaius phoeniceus*), Herring Gulls were the only species nesting on the island.

I first inspected the colony in 1973 from the air on 9 April. Starting on 26 April, I visited the island by boat every 2 to 3 days during April, May, and June (except for one 6-day interval in May) and then every 4 to 5 days until 18 July, with a final visit on 29 July. The visits, usually by two observers, were from 30 min to 2 h in length, and averaged about 1 h.

I marked all gull nests by writing a nest number in indelible felt pen on a nearby rock, which was also marked with a spot of orange paint to help in relocating the nest number. All eggs were numbered with a non-toxic felt pen

when first found, and in the sequence in which they were laid, if known. I banded each chick when I first found it, using standard United States Fish and Wildlife Service metal bands. On each visit, I recorded the numbers and condition of nests, eggs, and chicks. Eggs that were no longer being incubated, or were out of the nest and had been out on several successive visits, were collected, as were egg-shells found outside the nests and all dead chicks. In the laboratory, the contents of each egg were emptied into an acetone-rinsed glass jar and examined to determine, when possible, stage of development at death. Chicks were examined for injuries and pathological conditions, including endoparasites, bacterial infection, and malnutrition that could account for their deaths. Egg contents and dead chicks were frozen.

All egg-shells were air-dried for several weeks, after which the thickness of each shell was measured to the nearest 0.001 mm at five equidistant points around the girth, using a Starrett Model 1010 dial micrometer with ball anvils. Measurements included the shell membranes. I calculated thickness indices (Ratcliffe 1967) for those shells for which weights and dimensions were available.

All egg contents and brains were analyzed individually by gas-liquid chromatography for OC pesticide and polychlorinated biphenyl (PCB) residues at the Ontario Research Foundation. Each of the egg contents was also analyzed for total mercury. Moisture and fat percentages were determined for each egg and brain. The PCB values given are based on a reference mixture of Aroclor 1254:1260 (1:1). Analytical methods for OC pesticides and PCBs were described by Reynolds and Cooper (1975), and for mercury by Fimreite and Reynolds (1973).

Results

Breeding Biology

I believe the number of breeding pairs of Herring Gulls (pairs that built at least one nest and laid at least one egg) on Brothers Island in 1973 was 34; that number is used in computing the various statistics of breeding success. It was determined from the number of first clutches among the total 47 clutches initiated. Thirteen of those 47 were thought to be second clutches,

although it was not possible to know that with absolute certainty, since gull pairs were not marked. It has been established, however, that Herring Gull pairs usually re-nest in the immediate area of the previous nest (Paludan 1951) and usually initiate the second clutch 11 to 17 days after loss of the first (Goethe 1937; Paludan 1951). On these bases, and having regard to the fate of each earlier clutch and to the spatial locations and times of initiation of the 13 clutches, I concluded that they were second clutches.

The gulls were already occupying territories on 9 April. On 26 April there were 34 nests, of which five were incomplete. Four clutches had been completed (i.e., contained no additional eggs on subsequent visits) and 11 others started. The median date of initiation of first clutches was 28 April (Figure 1), and 68% of those clutches were initiated during the 12-day period 22 April to 3 May. Dates of initiation of the 14 clutches begun prior to my first visit were estimated by back-dating from the date of clutch completion or hatching. One clutch was complete at the time of my first visit, but failed to hatch; I am certain only that it was begun prior to 23 April. The median date of initiation of clutches regarded as repeat layings was 19 May (Figure 1).

Sixty nests were completed during the season, of which 46 contained at least one egg, while the remaining 14 were abandoned or destroyed prior to the start of egg-laying (Table 1). Many of the abandoned/destroyed nests were built close to the water's edge, and were subject to the effects of wave action. One of the 46 nests with eggs had both a first and second clutch laid in it, the first clutch having disappeared during egg-laying; 12 other nests among the 46 are believed to have been re-nestings resulting from failure of the original attempt. Twenty-one nests contained eggs that hatched and 25, including 15 of the 21 with eggs that hatched, are known to have contained eggs that were infertile or had dead embryos.

The total number of eggs found in the colony was 124, comprising 44 completed clutches and three that were abandoned or destroyed prior to completion. Of the 124 eggs found, 28, or 23%, hatched. Of the remaining 96 that failed to

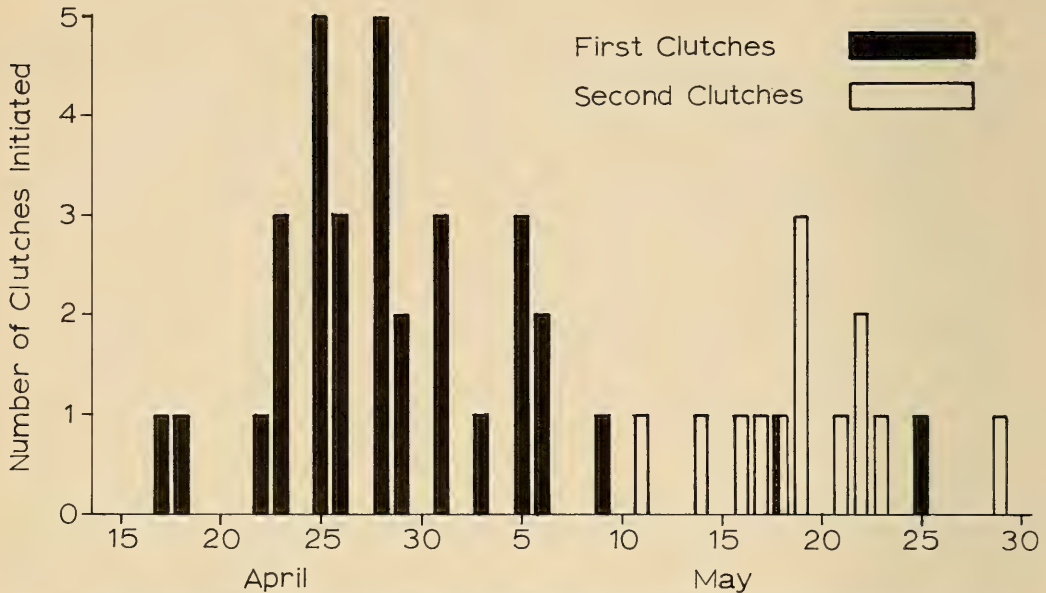


FIGURE 1. Dates of initiation of 33 first clutches and 13 second clutches by Herring Gulls on Brothers Island in 1973.

hatch, 38% were infertile or failed because of embryonic mortality, 17% disappeared from the nest, 25% disappeared when the entire nest was destroyed, and 21% failed for various other reasons, including destruction by adult gulls and

rolling out of the nest. Table 2 details the fate of eggs in the colony. Hatching and fledging success in completed clutches is summarized in Table 3.

TABLE 1—Outcome of Herring Gull nests on Brothers Island in 1973

Total nests started	63
Not completed	3
Completed	60
Contained no eggs	14
Contained eggs	46 ¹
Clutch not completed — abandoned during egg-laying, when eggs disappeared or were out of nest	2
Clutch completed, incubated	44
Abandoned during incubation when eggs disappeared, were destroyed, or were out of nest	7
Destroyed during incubation, probably by wave action	9
Eggs failed to hatch	7
Hatched chicks	21

¹One of these nests contained two successive clutches, the first clutch having disappeared during egg-laying.

Sixteen eggs were collected from the colony. They represented either 12 or 13 different clutches, two of which were second clutches. Two of the eggs were fresh and 14 were rotten. No visible embryonic development had taken place in either fresh egg. Of the 14 rotten eggs, two had been rolled from the nest during early incubation, one had been incubated 16 to 19 days, and 11 had been incubated at least 27 days. Among those 12 eggs that had been incubated for a significant period, four showed no discernable embryonic development. Development in the remaining eight was estimated to be 1 to 25% in three, 51 to 75% in two, and 76 to 100% in three.

In all, there were 28 clutches (20 first clutches and 8 second clutches) in which at least one of the eggs in the clutch remained intact through 27 days of incubation. The fate of the 80 eggs found in those clutches is summarized in Table 4. Among the 61 eggs that were incubated 27 or more days, 28 (46%) hatched and 33 (54%) failed to hatch owing to infertility or embryonic

TABLE 2—Fate of Herring Gull eggs on Brothers Island, 1973

	In 34 first clutches	In 13 second clutches	In all 47 clutches
During egg-laying			
Disappeared from nest	7	0	7
Out of nest	1	0	1
During incubation			
Disappeared from nest	6	3	9
Disappeared when nest destroyed, probably by wave action	24	0	24
Destroyed by adult gulls	3	5	8
Out of nest	6	3	9
Shell damaged	1	0	1
Embedded in nest	0	1	1
Infertile, or rotten early embryo not discernable	13	10	23
Embryo died before pipping	7	3	10
Pipped and died	3	0	3
Hatched	21	7	28
Totals	92	32	124

mortality. Those 28 clutches represented 28 of the 34 gull pairs in the colony.

The 28 chicks hatched represent 0.82 chicks per breeding pair. Thirteen of those were later found dead. Two chicks were known to have fledged (were seen flying) and four more were seen at 17 to 35 days of age, and may have fledged. Thus, 2–5% of eggs in the colony produced chicks that fledged. Of chicks that hatched, between 7 and 21% fledged. In terms of

chicks fledged per breeding pair of adults, these numbers represent 0.06 chicks known to have fledged and a maximum of 0.18 that may have fledged.

Chick Mortality and Chemical Residues in Brains

Of the 13 chicks found dead in the colony, 12 were collected. Ages at death ranged from a few hours to about 7 weeks. One chick, about 1 day

TABLE 3—Clutches completed by 34 Herring Gull pairs on Brothers Island, 1973

	Number of clutches	Number of clutches hatching chicks	Number of chicks hatched	Number of chicks fledged
First clutches ¹				
Two-egg	9	3	3	1(?)
Three-egg	22	12	18	2–5
Both two- and three-egg	31	15	21	2–6
Second clutches ¹				
Two-egg	7	3	3	0
Three-egg	6	3	4	0
Both two- and three-egg	13	6	7	0
Both clutches ¹				
Two-egg	16	6	6	1(?)
Three-egg	28	15	22	2–5
Both two- and three-egg	44	21	28	2–6 ²

¹At start of incubation.

²From six clutches.

TABLE 4—Fate of Herring Gull eggs found in 28 clutches in which at least one intact egg remained in the nest for 27 or more days of incubation, Brothers Island, 1973

	In 20 first clutches	In 8 second clutches	In all 28 clutches
During egg-laying			
Disappeared	5	1	6
During incubation			
Disappeared	3	1	4
Destroyed by adult gulls	3	1	4
Out of nest	3	0	3
Shell damaged	1	0	1
Embedded in nest	0	1	1
Incubated full term but failed to hatch	23	10	33
Hatched	21	7	28
Totals	59	21	80

old and near death, was in convulsions. Parasites were absent, and none of the chicks showed skull fractures to indicate it had been pecked by adult gulls. Six showed evidence of disease (four had diarrhoea, one had a very yellow liver, and one showed prominent convulsions in the kidney tubules); three, including two of the diseased ones, exhibited signs of malnutrition. No significant pathogenic bacteria were isolated from any of 10 from which tissues were cultured.

As the chicks gained weight brain residue levels of the various OC chemicals declined rapidly, presumably as a result of the dilution effect of the increase in body tissue. Seven of the 12 chicks for which brain analyses were done weighed 56 g or less, and may be regarded as newly-hatched chicks. Among those seven, the geometric mean and 95% confidence interval for DDE, in parts per million (ppm) or milligrams per kilogram dry weight were 147 and 102–213; for PCBs, 651 and 491–864. Mean brain residues and confidence intervals in the other five chicks weighing 140–724 g were 27.7 and 10.9–70.4 ppm DDE and 135 and 53.6–341 ppm PCBs. Low levels of dieldrin, *p,p'*DDT, heptachlor epoxide, and hexachlorobenzene were also detected in each of the 12 brains. In the brains of the seven small chicks, concentrations of each of the above chemicals were less than 7 ppm dry weight and in the five larger chicks, less than 2 ppm. Residue levels on a wet weight basis in the seven smaller and five larger chicks may be calculated by multiplying the dry weight values by 0.14 and 0.16, respectively.

Chemical Residues in Eggs and Shell Thickness

The contents of each of 15 eggs were analyzed for OC pesticides, PCBs and total mercury. Geometric means and 95% confidence intervals for DDE and PCBs in those 15 eggs are compared in Table 5 to similar measurements from eggs collected in 1972 in Lakes Huron (Georgian Bay), Erie, and Ontario, and the Gulf of St. Lawrence and the Bay of Fundy, New Brunswick (Gilbertson and Reynolds 1974). The arithmetic mean and 95% confidence interval for DDE on a dry weight basis in those 15 eggs were 144 and 110 to 178, and for PCBs 456 and 345 to 567. Since the eggs analyzed in this study had partially dehydrated prior to collection, it was not possible to calculate a factor for converting residue levels from a dry weight to a wet weight basis. However, the mean conversion factor for 160 *fresh* Herring Gull eggs from the Great Lakes was 0.24 (standard deviation 0.01) (internal Canadian Wildlife Service report from the Ontario Research Foundation). Approximate residue levels on a wet weight basis may be obtained by multiplying the dry weight levels by that factor.

Dieldrin, *p,p'*DDD, *p,p'*DDT, heptachlor epoxide, β -benzene hexachloride, hexachlorobenzene, and mercury were also found in each egg, but in every case at concentrations less than 6 ppm dry weight.

Thirteen of the eggs collected had shells that remained sufficiently intact to allow shell thickness measurement. The arithmetic mean and 95% confidence interval for the 13 were

TABLE 5—Residue levels of DDE and PCBs in Herring Gull eggs from eastern Canada¹

Location (Number of colonies)	Year of collection	Number of eggs	Residues in ppm dry weight Geometric mean and 95% C.I.	
			DDE	PCBs
Lake Huron (2)	1972	5	110 65–185	368 206–656
Lake Erie (3)	1972	6	48.0 33.0–70.1	300 244–369
Lake Ontario (8)	1972	16	131 104–164	565 436–730
Lake Ontario (Brothers Island)	1973	15	134 107–167	420 332–531
Gulf of St. Lawrence (2)	1972	16	32.1 20.4–50.6	65.2 47.1–90.3
Bay of Fundy (1)	1972	5	14.1 7.58–26.1	25.4 15.6–41.2

¹From Gilbertson and Reynolds (1974 and personal communication), except Brothers Island eggs, which were from this study.

0.339 mm and 0.327–0.351 mm (Table 6). The regression of shell thickness on concentration of DDE in the egg was calculated for the 12 eggs for which both thickness and residue data were available (Figure 2). The F-test showed that the slope of the first order regression line is highly significant ($F_{1,10} = 12.1$, $P < 0.01$), and that a second order regression gave no significant improvement in fit.

Discussion

The breeding success found in the Brothers Island Herring Gull colony in 1973, between 0.06 and 0.18 fledged chicks per breeding pair, is among the lowest reported for any North American Herring Gull population. By contrast, Paynter (1949) reported 0.91 fledged young per breeding pair in New Brunswick, Kadlec and Drury (1968) found 0.8–1.4 for various colonies

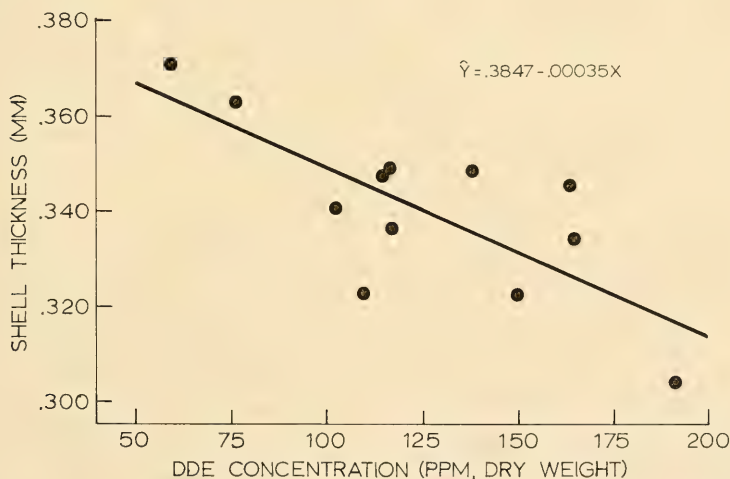


FIGURE 2. Shell thickness versus DDE concentration in 12 Herring Gull eggs that did not hatch, Brothers Island, 1973.

TABLE 6—Shell thicknesses and thickness indices for Herring Gull eggs from eastern North America

Location	Year(s) of collection	Number of eggs ¹	Shell thickness (mm)		Thickness index	
			Arithmetic mean 95% C.I.	Percent change from pre-1947	Arithmetic mean 95% C.I.	Percent change from pre-1947
Great Lakes ²	Pre-1947	456 (369)	0.375 0.373–0.377	—	1.73 1.72–1.74	—
Great Lakes ²	1960–1969	190 (151)	0.338 0.334–0.342	–10	1.55 1.53–1.57	–10
Lake Michigan ³ (Green Bay)	1970	10 (10)	0.328 0.307–0.349	–12	1.49 1.39–1.59	–14
Lake Ontario ⁴ (8 colonies)	1972	16 (16)	0.309 0.298–0.320	–18	1.58 1.54–1.62	–9
Lake Ontario ⁵ (Brothers Is.)	1973	11 (13)	0.339 0.327–0.351	–10	1.60 1.53–1.67	–8
Atlantic Coast ²	Pre-1947	598 (513)	0.372 0.370–0.374	—	1.77 1.76–1.78	—
Atlantic Coast ²	1963–1969	41 (41)	0.369 0.361–0.377	–1	1.68 1.64–1.72	–5

¹Numbers in parentheses are sample sizes for thickness only.²From Anderson and Hickey (1972).³From Faber and Hickey (1973).⁴From Gilbertson (1974 and personal communication).⁵From this paper.

on the New England coast, and Keith (1966) reported 0.3–0.4 for a Lake Michigan colony. Reproductive success on Brothers Island was similar to that reported by Gilbertson (1974), 0.06–0.21, for five Lake Ontario colonies.

When I first arrived on Brothers Island it was too late to determine the date of onset of nest building, but breeding appeared to be under way normally. Temporal dispersal of first clutch initiations was apparently normal, with 68% of starts taking place during a 12-day interval. Paludan (1951) found 68% of first clutches were initiated during a 14-day interval in both years of his study. In contrast to the prolonged renesting period, as late as mid-July, reported for Herring Gulls on Scotch Bonnet Island in eastern Lake Ontario in 1973 (Gilbertson and Hale 1974), renesting on Brothers Island was completed by 29 May.

The primary cause of reduced breeding success in the Brothers Island colony lay in the failure of 77% of the eggs to hatch. That rate of failure was somewhat higher than the 54–59% reported by Keith (1966) in Lake Michigan, but similar to the 84% reported for Scotch Bonnet Island by Gilbertson and Hale (1974).

Among the 37 eggs known to have been infertile or to have suffered embryonic mortality, 33 were incubated, intact, for at least 27 days. Among the 61 eggs that were incubated full term intact (33 that did not hatch and 28 that did) 54% failed to hatch. I believe those 61 eggs constituted an unbiased sample of all the eggs laid in the colony, and indicated that about 54% of all eggs laid were infertile or would have contained dead embryos prior to hatching. Paynter (1949) found that Herring Gull eggs that were infertile or contained dead embryos constituted only 8% of all eggs laid, and Paludan (1951) reported only 6%.

The mean number of eggs found in nests at the start of incubation was 2.71 for first clutches and 2.46 for second clutches. Corresponding clutch sizes reported by Paludan (1951) were 2.95 and 2.77, although it is not entirely clear whether his clutch sizes referred to eggs in nests at start of incubation or to total eggs laid, i.e., included eggs lost during egg-laying. If eggs lost during egg-laying are included for the Brothers Island colony, the mean sizes for first and second clutches that survived to start of incubation are 2.87 and 2.46, respectively.

Hatching success of eggs laid in 34 first clutches and 13 second clutches was 23% and 22%. In terms of chicks hatched per clutch, first clutches produced 0.62 chicks and second clutches, 0.54. The higher rate for first clutches is primarily due to the higher proportion containing three eggs rather than two.

Since the colony was small and the primary object of the study was to determine breeding success, I avoided random collecting of eggs or chicks for studies of embryonic death or chemical residues. But 5 of the 16 eggs collected may be regarded as randomly selected eggs; four, from four clutches, had rolled from the nest or were from a destroyed nest, and one was found, apparently uncubated, where there were no nests. These five are among those for which thickness and thickness index data are presented in Table 6. The remaining 11 eggs, from 9 clutches, were selected because they were infertile or contained dead embryos. Since Keith (1966) found no significant difference between DDE levels in live and dead Herring Gull eggs, and since mean DDE and PCB levels are not significantly different between eggs of this study and those collected randomly by Gilbertson from eight Lake Ontario colonies in 1972 (Gilbertson and Reynolds 1974, and personal communication) (Table 5), I have regarded those 11 eggs as comparable to randomly collected eggs used in other studies. Kreitzer (1972) reported that complete embryonic development of Coturnix Quail (*Coturnix japonica*) eggs resulted in a 7.3% thinning of the shells; only two of the Brothers Island gull eggs used for thickness and thickness index determinations showed embryonic development greater than 25%, and seven showed no development whatsoever.

Shells of the 13 eggs from Brothers Island (Table 6) were significantly thicker ($P < 0.001$) than the 16 shells collected from Lake Ontario in 1972 by Gilbertson (1974, and personal communication). However, they did not differ significantly in thickness ($P > 0.05$) from the 1960–1969 shells on which Anderson and Hickey (1972) reported, nor from the 1970 shells reported by Faber and Hickey (1973), and were significantly thinner ($P < 0.05$) than 369 pre-1947 shells measured by Anderson and Hickey (1972). Thickness indices (Table 6) were similar

to post-1947 ones, but significantly below those reported for pre-1947 shells ($P < 0.05$).

From the examination of 12 eggs that were incubated but failed to hatch, I could conclude only that embryonic death did not appear to be more common at any particular stage of development. This agrees with Keith's (1966) findings in a heavily organochlorine-contaminated population, and is at variance with those of Paludan (1951), who found that 80% of eggs that were infertile or had suffered embryonic mortality showed no apparent development. Paludan's results probably represent gull populations much less contaminated by organochlorines, since his work was done on the Danish coast in 1943 and 1944.

As well as a regression line of eggshell thickness on concentration of DDE in the egg (Figure 2), a regression line of egg-shell thickness on concentration of PCBs in the egg (dry weight basis) was also calculated ($y = 0.3834 - 0.00011x$, $r = 0.745$). The linearity and the r value are both highly significant, as they are for the DDE regression. This correlation, however, is presumably a spurious one, resulting from the linear relationship known to exist between levels of DDE and PCBs in Great Lakes Herring Gull eggs (Gilbertson 1974). There are several laboratory feeding studies showing egg-shell thinning effects of sublethal levels of DDE (Cooke 1973), but no such evidence that sublethal levels of PCBs cause any changes in egg-shell thickness (Peakall and Peakall 1973).

No obvious cause of death could be determined for 11 of the 12 chicks found dead and collected. Necropsy showed that fecal impaction in the cloaca, possibly related to malnutrition, could have accounted for the death of the other chick. Examination disclosed various disorders, including diarrhoea and malnutrition, in seven chicks, but gave no indication of what could have caused those conditions. Comparison of levels of DDE and DDT in the brains of the Brothers Island chicks with levels found by Hickey et al. (1966) in the brains of adult Herring Gulls indicated that those chemicals were probably not directly responsible for the deaths of the chicks. These comparisons with findings of Hickey et al. (1966) depend on the assumption that lethal brain levels of organochlorines in

chicks do not differ greatly from those in adults of the same species.

The literature concerning avian brain residue levels of dieldrin, heptachlor epoxide, hexachlorobenzene, and PCBs (Jefferies and Prestt 1966; Greenberg and Heye 1971; Faber et al. 1972; Koeman et al. 1973; Stickel et al. 1969) all deals with species other than gulls, and for heptachlor epoxide, hexachlorobenzene, and PCBs, gives no clear indication whether the levels found in the brains of the 12 chicks would have resulted in their deaths. Stickel et al. (1969) concluded that minimum lethal brain residue levels of dieldrin are remarkably similar among bird species, being 4 or 5 ppm wet weight. The highest dieldrin level found in brain tissue of the Brothers Island chicks was 0.47 ppm wet weight, and thus it is unlikely that any of those chicks died from direct dieldrin poisoning.

There remains the possibility that the cumulative effect of several OC chemicals together was lethal in those chicks that died soon after hatching, before body concentrations of OCs could be reduced by growth. Another possibility is that the excessive egg and chick mortality was due to ineffective parental care by adults carrying high loads of organochlorines. The presence of signs of malnutrition in three of the chicks found dead lends support to this hypothesis. That incubation behavior of birds can be upset by PCBs has been shown experimentally for Ring Doves (*Streptopelia risoria*) (Peakall and Peakall 1973).

I saw people on the island only twice, and I have no evidence to indicate that such visitors, or the fishermen who sometimes anchored offshore, had any significant effect on breeding success of the gulls.

The high pollutant levels and low breeding success found in the Brothers Island Herring Gull colony fit the pattern established for Herring Gulls elsewhere on the Great Lakes. Investigators have attributed other such low success rates to organochlorine pollutants, and the evidence from Brothers Island indicates the same association of high organochlorine levels with low breeding success there. The low breeding success took the form of reduced survival of both eggs and chicks. Whether that reduced survival was related to pollutants in the eggs and chicks, or to pollutants in the adult

gulls (causing aberrant behavior), or to both, remains unclear. However, the general association with pollutants is strong, particularly since other possible factors, such as disease, disturbance, and storms have been evaluated and do not account for the drastically low breeding success found.

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Weedy Species at Terminal Grain Elevators, Thunder Bay, Ontario

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Abstract. In 1975, a survey of adventive plants was carried out at the terminal grain elevators and adjacent railway yards, Thunder Bay, Ontario. A total of 146 species was recorded, of which 27 species have likely been introduced as contaminants in western grain shipments. Eleven species common to eastern Canada were also recorded. The weed flora at Thunder Bay shows somewhat similar composition to that found at another grain terminal at Churchill, Manitoba. There is no evidence that these adventives pose any serious threat to local agriculture.

The 19 terminal grain elevators at Thunder Bay, Ontario afford an unusual opportunity for study of ruderal assemblages of plants transported, in some cases, long distances as contaminants of grain shipments. Grain spillage from box cars is rather common and such spills may inadvertently lead to the introduction of weeds which have been previously harvested with associated grain or other crops.

An earlier survey by Beckett (1959) lists 76 species of adventives at the terminal elevator and railway yards of Churchill, Manitoba. She reports that 28 species probably do not persist but are introduced sporadically in grain shipments to that port. Unfortunately, her work has not been repeated so that an up-to-date listing of persistent species is not available.

In general, railway yards and rights-of-way provide unusual habitats for weedy plants. Such habitats differ considerably from those of cultivated fields, pastures, rangeland, and even vacant lots. In Wisconsin, Curtis (1959) showed a number of weeds achieved greater presence values in railway yards than in other plant communities.

Railway yards must have adequate drainage. Thus track ballast must be largely coarse aggregates of gravel and sand. In summer, heat and moisture conditions may fluctuate greatly and in winter snow cover is generally minimal. Even highway road shoulders, where some conditions may be similar to those of railway ballast, undergo more frequent grading and accumulations of salt than is found in railway yards. Soil nutrient conditions may also be important.

The purpose of the present study was three-

fold. Firstly, a check-list of all adventives was made at the terminal elevators. Secondly, this flora was compared with the studies carried out by Beckett (1959) and Curtis (1959) and finally, a check of local grain fields was carried out to ascertain if the grain terminal weeds posed any threat to local agriculture.

Description of Study Area

Figure 1 shows the general location of the area surveyed. For convenience, it was divided into eight sites commencing with the most westerly portion known as the "Neebing Yard" (Site 1) and ends with site 8 in the northeast section of Thunder Bay. The total distance between sites 1 and 8 is about 20 k (12.6 mi). A typical site is shown in Figure 2.

The over-all terrain is generally flat and was formerly submerged by high levels of Lake Superior during the last post-glacial period. The original organic soils have been greatly modified by improved drainage and track ballast in the railway yards. For the most part, all sites except site 5 are rather uniform as to age of existence. Site 5, known as the Keefer Terminal, was opened in 1962 for shipment of general cargo and is not involved in the trans shipment of grain as are the elevators. Also, site 7 is a small holding stockyard for livestock and was included in the survey because of possible weed introduction in hay used to feed the animals.

Methods

Each site was visited several times from May through September 1975 and presence lists were compiled for each site. All introduced weeds and

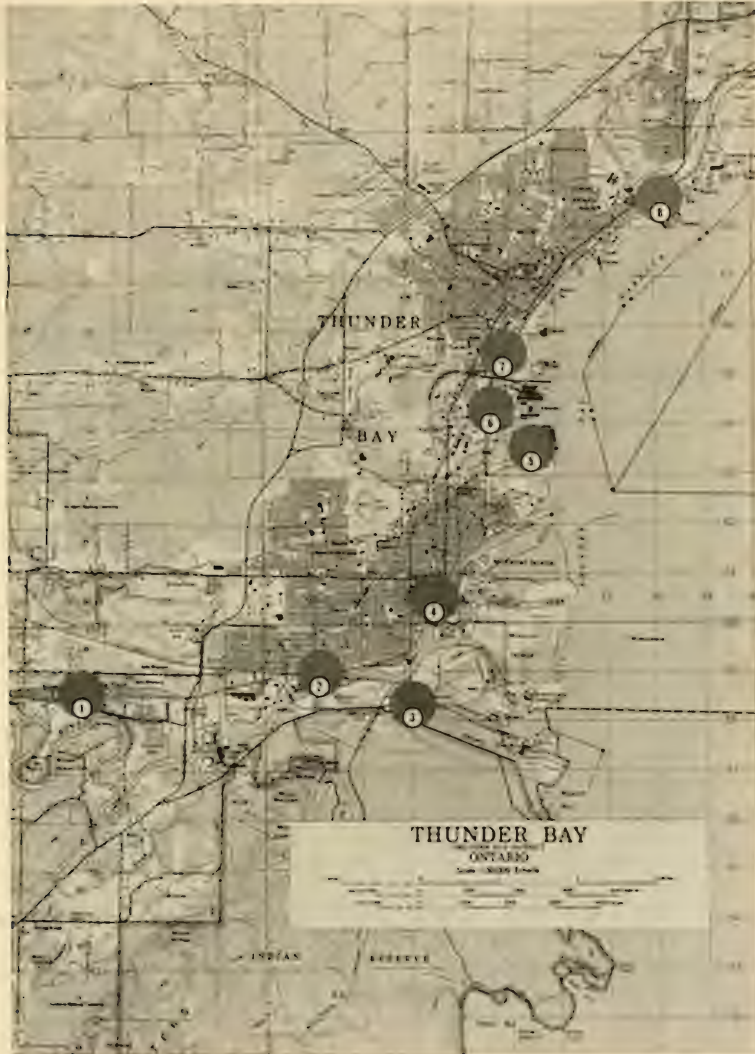


FIGURE 1. Location of eight sites sampled at terminal grain elevators and railway yards, Thunder Bay, Ontario.

native adventive plants were recorded and voucher specimens collected. The area surveyed included 17 of 19 elevators with their adjacent yards. Intervening track areas between sites were also traversed on foot. Although some areas were restricted, and, owing to hazards of shunting trains, all tracks could not be surveyed; I am confident, however, that few plants escaped detection.

Percentage of species in each plant family was calculated and compared with results obtained by Beckett (1959) and Curtis (1959). Species common to all three locations, Churchill, Wisconsin, and Thunder Bay, were also determined.

A total of 12 grain fields in the Lakehead area was surveyed for possible introduction of weeds found at the elevators.



FIGURE 2. Typical site (site 8). Toadflax (*Linaria vulgaris*) in foreground. This elevator was demolished in 1976.

Weeds of Canada (Frankton and Mulligan 1970) was used as a guide for the study.

Results

Table 1 lists by family all adventive plants found in this study. Species predominantly weedy in western Canada are preceded by 'w' and those of eastern Canada by 'e'. Autogamous species, previously determined by Mulligan and Findlay (1970), are designated by 'o'.

Weeds found at all sites included *Equisetum arvense*, *Agropyron repens*, *Panicum capillare* var. *capillare*, *Polygonum aviculare*, *Chenopodium album*, *Salsola pestifer*, *Amaranthus retroflexus*, *Capsella bursa-pastoris*, *Lepidium densiflorum*, *Potentilla norvegica*, *Medicago lupulina*, *Melilotus alba*, *Trifolium pratense*, *Linaria vulgaris*, *Plantago major*, *Achillea millefolium*, *Artemisia biennis*, *Crepis tectorum*, *Erigeron canadensis*, *Matricaria maritima* var.

TABLE 1—List of adventive plants compiled from all sites. w, Weedy in the Prairie Provinces; e, weedy in eastern Canada; o, autogamous species (after Mulligan and Findlay 1970)

Equisetaceae

- Equisetum arvense* L.
E. hymenale L. var. *affine* (Englm.) A. A. Eat.

Gramineae

- Agropyron repens* (L.) Beauv.
Agrostis scabra Willd.
w *Avena fatua* L.
Beckmannia syzigachne (Steud.) Fern.
Bromus inermis Leyss.
e *Digitaria ischaemum* (Schreb.) Muhl.
w *Echinochloa crusgalli* (L.) Beauv.
w *Hordeum jubatum* L.
w *Lolium persicum* Boiss. & Hoh.
e *Panicum capillare* L. var. *capillare*
P. miliaceum L.
Phleum pratense L.
Poa compressa L.
P. pratensis L.
Puccinellia nuttalliana (Schultes) Hitch.
wo *Setaria viridis* (L.) Beauv.

Urticaceae

- Urtica dioica* L. var. *procera* Wedd.

Santalaceae

- Commandra richardsiana* Fern.

Polygonaceae

- Rumex acetosella* L.
R. maritimus L. var. *fueginus* (Phillipi) Dusen.
R. mexicanus Meisn.
w *R. pseudonatronatus* Borbas
w *R. stenophyllus* Ledeb.
Polygonum achoreum Blake
o *P. aviculare* L.
o *P. convolvulus* L.
o *P. lapathifolium* L.
o *P. persicaria* L.
P. ramossissimum Michx.
o *P. scabrum* Moench.

Chenopodiaceae

- Atriplex hortensis* L.
A. patula L. var. *hastata* (L.) Gray
w *Axyris amaranthoides* L.
o *Chenopodium album* L.
o *C. glaucum* L.
C. gigantospermum Aellen
w *Corispermum hyssopifolium* L.
w *Kochia scoparia* (L.) Schrad.
w *Salsola pestifer* Nels

Amaranthaceae

- Amaranthus albus* L.
A. blitoides S. Wats.
wo *A. retroflexus* L.

Caryophyllaceae

- o *Cerastium vulgatum* L.
o *Lychnis alba* Mill.

Caryophyllaceae (cont.)

- w *Silene cserei* Baumg.
eo *S. cucubalus* Wibel
o *S. noctiflora* L.
o *Stellaria media* (L.) Vill.

Ranunculaceae

- eo *Ranunculus acris* L.

Papaveraceae

- Corydalis aurea* Willd.

Cruciferae

- Arabis glabra* (L.) Bernh.
Armoracia lapathifolia Gilib.
e *Barbarea vulgaris* R. Br.
Brassica campetris L.
B. juncea (L.) Czern.
o *Capsella bursa-pastoris* (L.) Medic.
wo *Descurainia sophia* (L.) Webb.
w *Erucastrum gallicum* (Willd.) O. E. Schulz
o *Erysimum cheiranthoides* L.
Lepidium campestre (L.) R. Br.
o *L. densiflorum* Schrad.
Sinapis alba L.
wo *S. arvensis* L.
wo *Sisymbrium altissimum* L.
w *S. loeselii* L.
wo *Thlaspi arvense* L.
o *Rorippa islandica* (Oeder) Borbas

Saxifragaceae

- Parnassia palustris* L. var. *neogaea* Fern.

Rosaceae

- o *Potentilla argentea* L.
P. anserina L.
P. norvegica L.

Leguminosae

- Lotus corniculatus* L.
o *Medicago lupulina* L.
M. sativa L.
Melilotus alba Desr.
M. officinalis (L.) Lam.
Trifolium hybridum L.
T. pratense L.
T. procumbens L.
Vicia cracca L.

Euphorbiaceae

- Euphorbia glyptosperma* Engelm.

Malvaceae

- Malva pusilla* Sm.

Onagraceae

- Epilobium angustifolium* L.
E. glandulosum Lehm. var. *adenocaulon* (Haussk.) Fern.
o *Oenothera biennis* L.

Table I (continued)

Umbelliferae	Compositae (cont.)
<i>Pastinaca sativa</i> L.	T. & G.
Apocynaceae	<i>A. vulgaris</i> L.
<i>Apocynum androsaemifolium</i> L.	<i>Aster ericoides</i> L.
Asclepiadaceae	<i>A. modestus</i> Lindl.
e <i>Asclepias syriaca</i> L.	<i>A. prealtus</i> L.
Polemoniaceae	<i>A. simplex</i> Willd. var. <i>ramosissimus</i> (T. & G.) Cronq.
<i>Collomia linearis</i> Nutt.	<i>Bidens cernua</i> L.
Boraginaceae	<i>B. frondosa</i> L.
eo <i>Echium vulgare</i> L.	<i>Chrysanthemum leucanthemum</i> L. var. <i>pinnatifidum</i> Lecoq & Lamotte
w <i>Lappula echinata</i> Gilib.	e <i>Cichorium intybus</i> L.
Labiatae	<i>Cirsium arvense</i> (L.) Scop.
w <i>Galeopsis tetrahit</i> L. var. <i>bifida</i> (Boenn.) Lej. & Court.	o <i>C. vulgare</i> (Savi) Tenore
<i>Mentha arvensis</i> L.	w <i>Crepis tectorum</i> L.
Scrophulariaceae	o <i>Erigeron (Conyza) canadensis</i> L.
<i>Chenorrhinum minus</i> (L.) Lange.	o <i>E. strigosus</i> Muhl.
<i>Euphrasia hudsoniana</i> Fern. & Weig.	w <i>Grindelia squarrosa</i> (Pursh) Dunal
<i>Linaria vulgaris</i> Mill.	<i>Helianthus annuus</i> L.
<i>Odontites serotina</i> (Lam.) Dum.	<i>H. maximilliana</i> Schrad.
eo <i>Verbascum thapsus</i> L.	<i>H. laetiflorus</i> Pers. var. <i>subrhomboideus</i> (Rydb.) Fern.
Plantaginaceae	<i>H. tuberosus</i> L.
o <i>Plantago major</i> L.	<i>Hieracium canadense</i> Michx.
Rubiaceae	<i>H. floribundum</i> Wimm. & Grab.
<i>Galium boreale</i> L.	w <i>Iva xanthifolia</i> Nutt.
Compositae	<i>Matricaria maritima</i> L. var. <i>agrestis</i> (Kna) Wilmott
<i>Achillea millefolium</i> L.	o <i>M. matricarioides</i> (Less.) Porter
e <i>Ambrosia artemisiifolia</i> L. var. <i>elatior</i> (L.) Desc.	<i>Rudbeckia serotina</i> Nutt.
<i>A. psilostachya</i> DC. var. <i>coronopifolia</i> (T. & G.) Farw.	o <i>Senecio vulgaris</i> L.
e <i>A. trifida</i> L.	<i>Solidago canadensis</i> L.
<i>Anaphalis margaritacea</i> (L.) C. B. Clarke	<i>S. gigantea</i> Ait.
o <i>Arctium minus</i> (Hill) Bernh.	<i>S. graminifolia</i> (L.) Salisb.
wo <i>Artemisia biennis</i> Willd.	w <i>Sonchus arvensis</i> L. var. <i>glabrescens</i> Guenth., Grab., & Wimm.
<i>A. caudata</i> Michx.	<i>Tanacetum vulgare</i> L.
<i>A. absinthium</i> L.	o <i>Taraxacum officinale</i> Weber
<i>A. ludoviciana</i> Nutt. var. <i>gnaphalodes</i> (Nutt.)	wo <i>Tragopogon dubius</i> Scop.
	<i>Xanthium strumarium</i> L.

agrestis, *M. matricarioides*, *Solidago canadensis*, *Sonchus arvensis* var. *glabrescens*, and *Taraxacum officinale*.

Some 55 species are recorded for the more recent Keefer Terminal (site 5), including the native plants *Parnassia palustris* var. *neogaea*, *Euphrasia hudsoniana*, and *Odontites serotina*. Such plants are probably "hold-overs" from a period prior to 1962 when the terminal was opened. This site has not yet acquired all of the species found at the elevators.

At the stockyard (site 7) the only survey record for *Barbarea vulgaris* was found. This plant was likely introduced in hay.

Some of the most serious weeds of western Canada such as *Euphorbia esula* L., *Cardaria draba* (L.) Desv., *Neslia paniculata* (L.) Desv., *Camelina microcarpa* Andr., *Conringia orientalis* (L.) Dumort., *Dracocephalum parviflorum* Nutt., *Iva axillaris* Pursh, and *Lactuca pulchella* (Pursh) DC. were not found. Records for all the preceding except *Cardaria draba* are known for the Thunder Bay District. The present survey also shows a possible new record for the province, *Rumex stenophyllus* Ledeb. which has been introduced from western Canada.

Of the eastern weeds, *Daucus carota* L.,

Convolvulus arvensis L., *Hypericum perforatum* L., and *Spergula arvensis* L. were not found but records are known for these plants in the district.

Table 2 shows a comparison of the principal plant families found at three widely separated locations. The high value for *Compositae* at Thunder Bay is due in part to the large number of native plants found in this study.

Forty-nine species found at Thunder Bay were also found in the Churchill study and 46 species were similar to a weed list based on data from 24 railway yards in Wisconsin. Species common to all three locations include *Poa pratensis*, *Agropyron repens*, *Hordeum jubatum*, *Phleum pratense*, *Setaria viridis*, *Polygonum aviculare*, *P. convolvulus*, *Chenopodium album*, *C. glaucum*, *C. gigantospermum*, *Lychnis alba*, *Lepidium densiflorum*, *Erucastrum gallicum*, *Potentilla norvegica*, *Trifolium hybridum*, *Melilotus alba*, *M. officinalis*, *Collomia linearis*, *Linaria vulgaris*, *Plantago major*, *Iva xanthifolia*, *Artemisia biennis*, *Cirsium arvense*, and *Taraxacum officinale*.

In the 12 local grain fields surveyed only *Sonchus arvensis* var. *glabrescens* and *Chenopodium album* were found in all fields, *Cirsium arvense* in four, *Arena fatua* in two, and *Polygonum scabrum* and *Setaria viridis* in one each. The "eastern" *Spergula arvensis* was found on one field but not at the elevator sites.

Discussion and Conclusions

There is little doubt that many weed species are introduced at the terminal elevators of Thunder Bay through leakage and grain spills from railway box cars. Unfortunately, I was not

able to analyze grain samples for identification of weed contaminants and to correlate species with those found on the sites. The new Government of Canada hopper cars minimize such spillage and if some further cleaning could be done at points of origin, further reduction of contaminants would result. A few elevators have landscaped their property and this has resulted in more pleasing aesthetic effect. Spraying of yard species, in my view, would only increase a fire hazard.

This study has not been able to prove persistence of these weeds. It is suspected that some plants such as *Arena fatua*, *Lolium pericium*, and *Axyris amaranthoides* must be introduced each year. Others such as *Linaria vulgaris* and *Crepis tectorum* appear to be well established and have spread into suitable habitats within the city. Ragweeds (*Ambrosia* spp., *Iva* spp.) and the members of the *Chenopodiaceae* pose some threat to hay-fever sufferers. Thus far, however, the elevator plants are not a menace to local grain fields which are rather scattered and of small acreage.

Floristic comparisons between the present study and other railway yards have shown a similarity, in which the major component of each is encompassed by a few plant families. At Thunder Bay, some 38 species are autogamous weeds, as determined by Mulligan and Findlay (1970). Mulligan (1972) has pointed out that such plants may have a decided advantage for establishment after long-distance dispersal. Of the 24 species common to all three railway yard locations, nine are autogamous species. Recently, Grime (1974) has used a triangular ordination of vegetation in the Sheffield area in

TABLE 2—Percentage of total species in principal plant families represented at three railway yard locations

Plant family	Curtis (Wisconsin)	Beckett (Churchill)	Present study (Thunder Bay)
Compositae	18.6	13.2	30.2
Gramineae	14.8	15.8	10.9
Cruciferae	7.7	21.0	11.6
Polygonaceae	6.6	5.2	8.2
Leguminosae	4.9	10.5	6.1
Chenopodiaceae	not recorded	10.5	6.1
Caryophyllaceae	not recorded	5.2	4.1

Great Britain, based on degree of competition, stress, and disturbance. He has shown ordination patterns of railway ballast plants to be similar to some communities of wasteland but quite different from those of meadows, pastures, and roadsides.

It would seem that further studies would be useful to develop more quantitative methods in weed ecology. Lastly, more work should be done on the environmental factors found in railway yards. In this study *Beckmannia syzigachne* and *Puccinellia nuttalliana* are native plants found in more saline soils of western Canada. The physical and chemical properties of ballast soils, moisture and temperature regimes as related to the life cycles of these and other plants might be revealing.

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Increase in Overwintering by the American Goldfinch, *Carduelis tristis*, in Ontario

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Middleton, A. L. A. 1977. Increase in overwintering by the American Goldfinch, *Carduelis tristis*, in Ontario. *Canadian Field-Naturalist* 91(2): 165-172.

Abstract. Between mid-November and mid-May from 1970 until 1975, 3433 American Goldfinches, *Carduelis tristis*, were banded at Guelph, Ontario. Banding results show that many goldfinches now winter in Guelph. Analysis of the annual Christmas Bird Count data shows that a significant increase has occurred in overwintering goldfinch populations in southern Ontario since 1915. This population increase cannot be attributed solely to climatic amelioration, and is apparently related to an abundance of food provided at feeding stations. As a result the goldfinch is now a common winter resident in the urban areas of southern Ontario.

Snyder (1957) and de Vos (1964) have summarized the marked changes which have occurred in the avifauna of Ontario during the past century, while von Haartman (1973) has reported similar changes in northern Europe. Three causes have been proposed to explain these changes: an increase in the number of bird watchers, an amelioration of the climate, and an alteration of the habitat by man (von Haartman 1973). In addition to the obvious changes which accompany habitat alteration, less obvious and more subtle changes, such as the adaptation by indigenous species to urban environments and conditions, have occurred and probably still are occurring (Tast 1968; Ward 1968).

In Ontario the number of bird watchers has undoubtedly increased (records of annual Christmas Bird Counts), the climate is probably a little milder than a century ago, although the last 20 years has seen a return to colder, snowier conditions (M. K. Thomas, unpublished manuscript), and modern agriculture and urbanization have modified the original environments and created new ones. In response to man-made changes, birds either decline (Wallace 1970; Batten 1972; Emlen 1974) or adapt to the new environment (Tast 1968; Ward 1968; Boshko 1971; Emlen 1974). In those parts of the world recently settled by European man, e.g., North America and Australia, adaptation by birds to ecologically disturbed conditions is presumably at an earlier stage than in Europe. Thus many avian species in North America such as the Blue Jay, *Cyanocitta cristata*, (Bock and Lepthien 1976a) may be adapting to new conditions.

In Guelph, Ontario, a large population of the American Goldfinch, *Carduelis tristis*, now regularly overwinters, whereas wintering by goldfinches in Ontario was not common in former years (McIlwraith 1894; Snyder 1951). This paper documents an increase in winter populations of the American Goldfinch in Ontario during the past 60 years and attempts to explain its cause.

Methods and Materials

Between mid-November and mid-May 1970-1975, goldfinches were trapped and banded at Guelph, Ontario using baited Potter traps. At capture each bird was sexed and weighed to the nearest 0.5 g. For the purposes of this paper, banding data were used only to determine the size of the overwintering populations at Guelph (Davis 1963). Although banding was mainly carried out at two locations, separated by 1.5 km in the center and west of the city, four other sites were used during the study (all to the south of the main areas, within a radius of 4.5 km). In addition my banded birds were captured by two other banders within Guelph.

Data on winter goldfinch populations in southern Ontario (localities south of 46°N) were obtained from the published results of the annual Christmas Bird Counts. The data were calculated on the basis of number of birds counted per party hour per year. This method was considered the most appropriate (Raynor 1975) and valid in view of the various sources of error inherent in the original data (Bock and Smith 1971).

In a part of Ontario as large as that defined above it is difficult to obtain weather data which are equally applicable to the entire area. But, accepting that an intensive study of few data from very few representative locations gives a valid indication of weather trends over a large area (Thomas, personal communication) and that weather data from a single station in southern Ontario roughly parallel those from other stations in the same area (Thomas 1957), it was felt that the Guelph data would suffice to show climatic trends throughout southern Ontario since 1915. Thus, 10-year moving means (Thomas 1968) were calculated for temperature and snowfall in Guelph in December (the month in which most Christmas Bird Counts are made), from data provided by the Weather Records Branch, Department of Land Resource Science, University of Guelph. These data were supplemented by data from Environment Canada for temperature in Ontario and snowfall in Ontario and Quebec (Thomas 1975). In the absence of matching long-term Christmas Count data from Guelph, a regression analysis was made between the weather data and the goldfinch data for Ontario to see whether any correlation existed.

An attempt was made to determine the size and importance of the wild-bird seed industry within Ontario and the scale on which wild-bird feeding has increased in recent years. Statistics on the sales of wild-bird seed in the province were sought from 25 companies, both wholesale and retail, and from the Ontario Ministry of Agriculture and Food and the Canadian Seed Trade Association.

Results

During the study, 3433 goldfinches were

banded at Guelph, Ontario. Considerable movement of banded birds apparently occurred within the city during winter since the percentage of retraps at the site of last capture varied 46–55% in different years.

Between 1970 and 1975, with the exception of the unusually mild and wet autumn of 1974, goldfinches first appeared at feeding stations within Guelph in mid-November. By late November large flocks were usually common within the city. This winter population remained until early May when feeding stations were gradually abandoned by the birds. A simple analysis of the capture-recapture data for April showed that the number of birds in overwintering flocks in Guelph varied between 853 in 1971–72 and 1816 in 1972–73 (Table 1).

Figure 1 shows the fluctuation in winter weights of goldfinches at Guelph. No significant differences were found in the weights between years. As a result the goldfinch weight data were pooled by sex. Maximum body weight was reached in December-January, followed by a gradual decrease until mid-March. A slight increase in weight occurred in late March followed by a significant ($P \leq 0.05$, Student's *t*-test) decrease in April and May. Pre-nuptial molt begins in the population in mid-March and continues throughout April and May (Middleton, in press). Migration apparently occurs during May (Tyler 1968), coinciding in Guelph with the abandonment of feeding stations by the winter goldfinch population.

Figure 2, from the Christmas Bird Count data for all centers in Ontario, shows an increase in the winter goldfinch populations between 1915 and 1975. The average number of birds counted/party hour increased significantly ($P \leq 0.01$,

TABLE 1—Population estimates ($N = \frac{Mn}{m}$) for April goldfinch flocks, Guelph, Ontario, 1970–1975

Season	Total banded, M	April sample, n	Number marked, m	Population estimate, $N \pm SE$	95% confidence limits
1970–71	541	64	22	1574 ± 271.8	1030–2118
1971–72	461	124	67	853 ± 70.7	711–995
1972–73	536	166	49	1816 ± 217.8	1380–2252
1973–74	751	57	35	1225 ± 128.6	967–1483
1974–75	533	96	47	1089 ± 113.5	863–1315

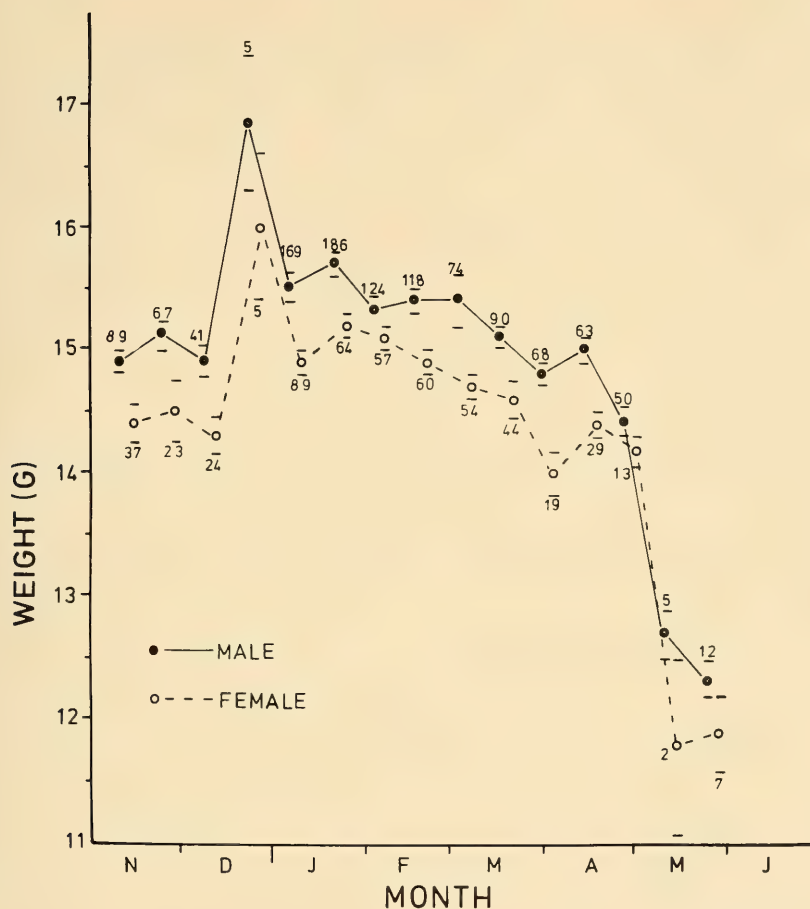


FIGURE 1. Mean (\pm SE) body weight of goldfinches trapped during winter at Guelph, Ontario, 1967–1974. Horizontal bars indicate one standard error; numbers give sample size for each sex.

Mann-Whitney U-test) from 0.12 ± 0.004 in 1915–1924 to 1.76 ± 0.183 in 1966–1975.

The 10-year moving means for temperature and snowfall for December at Guelph are shown in Figure 3. December temperatures reached a peak in the mid-1950s, followed by much colder conditions and a recent gradual return to milder temperatures. Snowfall declined steadily until the early 1960s since when there has been a return to much snowier conditions. These data are reflected in the annual data compiled by Environment Canada (Figure 4).

Regression analyses showed a significant ($P \leq 0.01$) negative correlation between snowfall and population ($Y = 28.525 - 1.713x$, $r = -0.392$, $n = 60$) and a less significant ($P \leq 0.05$) negative correlation between temperature and population ($Y = -3.971 + -119x$, $r = -0.25$, $n = 60$). Analysis of the data for 50 years (1915–1964) instead of 60 years (1915–1974), however, showed the correlation between snowfall and population to be more pronounced ($r = -0.546$, $P \leq 0.01$) whereas that of temperature was insignificant ($r = -0.118$).

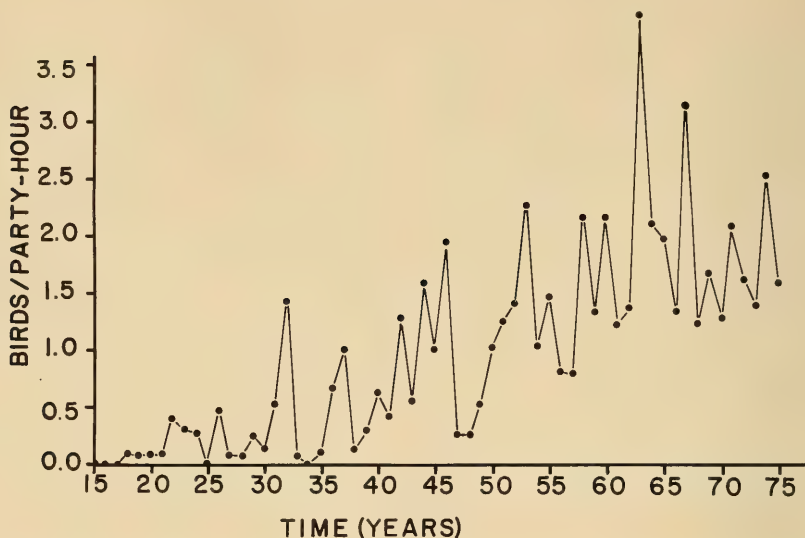


FIGURE 2. Index of winter American Goldfinch numbers within southern Ontario, 1915–1975, as calculated from annual Christmas Bird Count data.

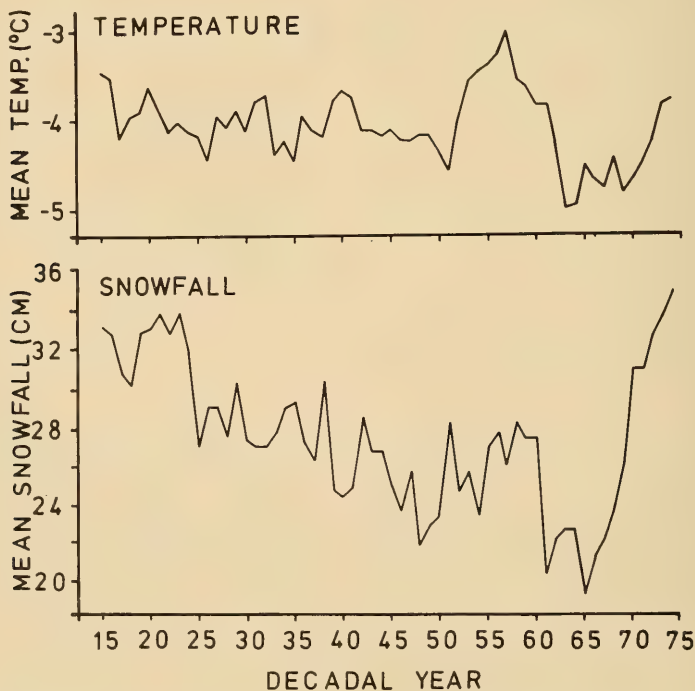


FIGURE 3. Ten-year moving means of snowfall and temperature at Guelph, Ontario, 1915–1974.

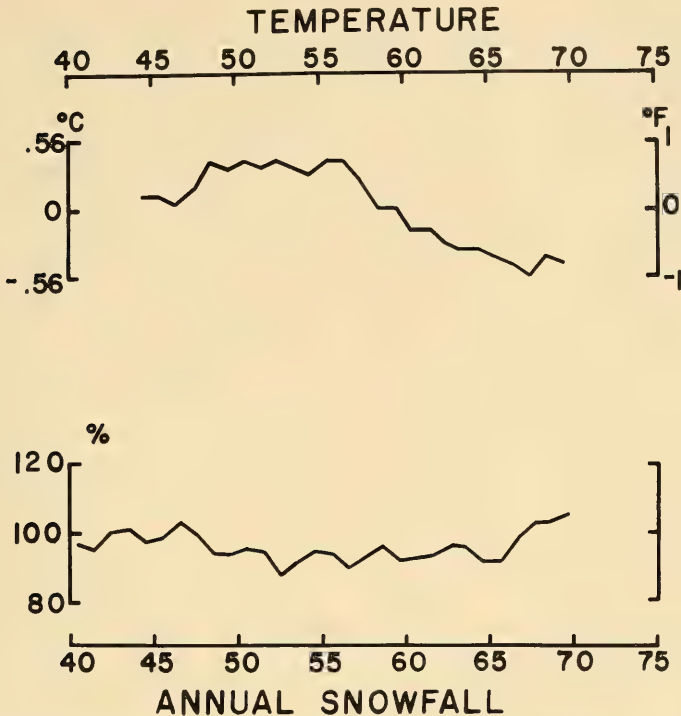


FIGURE 4. Temperature and snowfall trends for southern Canada, 1940–1970, as based on records of Environment Canada (Thomas 1975). (Temperature data from airports at Kapuskasing, London, and Ottawa. Snowfall data from airports at Toronto, Ottawa, Montreal, and Quebec City.)

Over the 4-year period for which data were obtained (1969–1973), wholesale sales (records of three companies) of seed for feeding wild birds rose by 50% from 340 tons to 510 tons. Retail sales for the same period (records of five companies) showed an increase of 131% from 350 tons to 810 tons.

Discussion

Traditionally it has been accepted that goldfinches in Ontario and neighboring regions migrate south for the winter (Dawson 1903; Dionne 1906; Snyder 1951; Godfrey 1966; Tyler 1968). It is known that goldfinches do migrate (records of Bird-Banding Office, United States Fish and Wildlife Service; A. L. A. Middleton, unpublished), but there are records to suggest that some goldfinches have consistently attempted to overwinter in southern Ontario and neigh-

boring regions (McIlwraith 1894; Dawson 1903; Barrows 1912; Snyder 1951; Forbush and May 1955). Attempts at overwintering may have been more common than reported as the goldfinch is inconspicuous during winter and often feeds with other species (Tyler 1968). Additionally, as the goldfinch feeds mainly on the seeds of the compositae (A. L. A. Middleton, unpublished) it is less dependent on the seeds of trees than other northern carduelines. As a result, its populations do not show the marked fluctuations during winter which make other species conspicuous by their presence or absence (Bock and Lepthien 1976b). Thus the presence of the goldfinch can be easily overlooked. The evidence shows, however, that during the last 60 years overwintering by goldfinches in Ontario has increased significantly (Figure 2) and that large numbers of goldfinches now regularly over-

winter in Guelph.

The winter weights at Guelph roughly correspond to those of the goldfinch in Ohio (Wiseman 1975) and show a similar trend to those of other finches in winter (Bartleson and Jenson 1955; King and Farner 1966; Newton 1969, 1972). The increase in weight observed in late March – early April is apparently associated with the prenuptial molt (Middleton, in press). The significant decrease in weight which follows is probably related to migration. An increase in body weight is common in molting birds (King and Farner 1966; Haukioja 1969; Newton 1969; Payne 1972), resulting from an increase in lean dry weight, fat, water content of the feather, and blood volume, all associated with growth of the feather papilla (Payne 1972). But molt also involves increased energy demands and an increase in metabolic rate (Payne 1972). Late March and April in southern Ontario are climatically unpredictable with highly variable temperatures (range of means -6.9° to 9.5°C), irregular snowfalls (range of means -0.0 to 54.9 cm), and frequent freezing rain storms (Weather Records Branch, Department of Land Resource Science, University of Guelph). Such unpredictable and stormy weather is known to cause increased mortality in molting birds (Haukioja 1969), yet at Guelph there was no apparent increase in mortality and the birds gained weight. Newton (1967) has pointed out that when feeding conditions are worst a bird's food requirements are often greatest. Starving bullfinches, *Pyrrhula pyrrhula*, could outlive their fat reserves for only a few hours, and Newton (1969) suggested that in hard weather the ability to accumulate sufficient fat each day was a critical factor affecting overnight survival.

Thus to survive the Ontario winter, goldfinches have to find sufficient food during January and February, and then to survive the prenuptial molt with its increased energy demands and decreased plumage insulation at a time of inclement weather and food shortage. It seems likely, therefore, that late winter formerly must have been a time of high mortality in any population of goldfinches overwintering in southern Ontario.

Winter weather has ameliorated slightly during the past century, but since the late 1950s mean winter temperatures have been lower,

accompanied by a return to snowier conditions (M. K. Thomas, unpublished manuscript). These trends are reflected in the December weather conditions at Guelph (Figure 3) and for Ontario as a whole (Figure 4). Within large urban areas, however, an "urban effect" often produces a dome of air over the city which may be several degrees warmer than the air of the surrounding countryside (Thomas 1968).

If, as argued, the December weather conditions at Guelph reflect the conditions throughout southern Ontario, there is a distinct negative correlation between temperature and snowfall with goldfinch population increases, snowfall having the higher correlation. These data suggest that in the early part of the population increase, the goldfinch responded directly to reduced snowfall by attempting to overwinter in Ontario. A decrease in snowfall would have resulted in the prolonged availability of, and easier access to, the natural food supply. At the present time the goldfinch may still respond directly to snowfall since its appearance at winter feeding stations coincides with the first snowfalls in November. The poor correlations between population increase and temperature suggest that temperature in itself has not contributed directly to the observed population increases, although the influence of the urban effect is not known. Thus climatic amelioration, as evidenced by reduced snowfall, probably influenced the increase in goldfinch populations in its early stages, but the evidence now suggests that winter populations are continuing to increase, uninfluenced by weather conditions. As von Haartman (1973) has indicated, climatic change alone cannot explain the marked changes in the avifauna of northern Europe, and it seems unlikely that climatic amelioration can be the sole cause of overwintering by goldfinches in Ontario.

Among others, de Vos (1964), von Haartman (1973), Alison (1976), and Bock and Lepthien (1976a) have pointed out the importance of winter feeding in the increased overwinter survival and range expansion of several species, and I suspect this is the key to successful overwintering by goldfinches in Ontario. It is difficult to estimate the real increase in the number of feeding stations in a city such as Guelph during the past, but in Ontario the sales

of bird seed have shown a marked growth in recent years, probably continuing a trend established previously. Although each individual feeder may supply a limited amount of food each day, the total amount of food supplied by all the people feeding wild birds within a city such as Guelph must be considerable. Emlen (1974) estimated that on his study area in Tucson, Arizona, an area little affected by severe winter weather, about half of the avian community's need was provided by food at feeding stations.

The abundance of food now being provided during winter within settled areas of Ontario has created a new situation for some birds. For seed-eating species, winter need no longer be a season of food shortage, provided these species can exploit the new food supply. The regularity with which the goldfinch reappears at feeding stations in Guelph, coincident with the first snows of winter, suggests that this species now recognizes the urban environment as a reliable food source when conditions are severe. The amount of movement which occurs between feeding stations suggests the birds move readily throughout the city, stopping wherever food can be found. There is no reason to believe that goldfinches in Guelph should behave differently from those in other parts of southern Ontario. Thus, with its ability to exploit this new, abundant food supply, the goldfinch now has become a common winter resident in the urbanized areas of southern Ontario.

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Notes

Incidence of the Dark Color Phase in Tundra and Taiga Populations of Northern Red-backed Voles, *Clethrionomys rutilus*

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Zimmerman (1961) reported two groups of darkening-genes in the genus *Clethrionomys*: 1, the recessive alleles of the agouti series, *a* (entirely black) and *a/t* (black with light belly); and 2, the dominant darkening-gene *proteus*. It is the latter group (*proteus*) that has usually been referred to in the literature as 'dark phase.'

Dark-phase individuals, those with a distinctly sepia, fuscous, or similarly colored dorsal stripe, have been reported in a number of populations of *Clethrionomys gapperi*, the southern red-backed vole, but reports of the dark phase in *C. rutilus*, the northern red-backed vole, are few. Dice (1921) captured two in interior Alaska, and Manning (1956) in his monograph on *C. rutilus* in Canada reported that only 3 of 386 skins examined were dark phase. Zimmerman (1961) captured a female *C. rutilus* in Manchuria which produced dark-phase young, but noted that not a single dark-phase individual was found among more than 3000 wild-caught palearctic specimens.

Zimmerman's subsequent breeding experiments with *C. rutilus* demonstrated some important characteristics of the gene *proteus*. Young *proteus* have a blackish-brown dorsal stripe when they are in the nest and are in their first subadult coat. At every further molt, however, the amount of black pigment decreases until, in the last stage, a light sepia-brown color is attained. Individuals in later molts had not previously been recognized as dark-phase. Zimmerman found that the direction of color change was always from dark to light but that the rate was extremely variable between individuals; some reached the lightest colors within 3–8 months while others were still very dark at 15–16 months of age. Zimmerman suggested that the variability was due to a more rapid fading process in heterozygotes than in homozygotes. Of 83 known *proteus* examined by Zimmerman only 25% fell into his two darkest color grades, which are

likely the only grades previously recognized as dark-phase. The proportion of *proteus* in natural populations, therefore, has been greatly underestimated.

I examined 2607 specimens of *C. rutilus* captured from tundra and taiga east of the Mackenzie Delta, Northwest Territories from May through October, 1971 to 1973. Taiga collections were made within 6 km southeast of Inuvik (68°00' N, 133°34' W) and tundra collections were made at several locations between 68°50' and 69°40' N, and 133°30' and 135°10' W. Neither tundra nor taiga populations offered impressive evidence of being cyclic (Martell 1975). Taiga population indices at the beginning of summer decreased from 1971 to 1973 but late summer indices were higher in 1971 and 1973 than in 1972. Tundra population indices were lower than those in the taiga and were probably similar, and very low, each year at the beginning of summer and were likely similar in 1971 and 1972 but lower in 1973 at the end of summer. Each vole was classed as overwintered (at least 8 months old), early cohort (born in June), or late cohort (born in July and August) based on M2 root development (Martell 1975). Because I was not aware of Zimmerman's paper at the time I was examining the specimens, only individuals with a distinctly dark dorsal stripe were identified as dark-phase. Those individuals would probably fall into Zimmerman's two darkest color grades for *proteus*. Data from taiga collections were examined by month and year for each age class but no significant differences in incidence of the dark phase were found either between years in a given month or between months either within a year or for all years grouped. Therefore the data are presented grouped by year (Table 1). The G-test was used throughout the statistical analysis. Representative specimens have been placed in the Museum of Zoology of the University of Alberta.

In the taiga sample there was no significant difference between years in the proportion of dark-

TABLE 1—Percentage of dark-phase *Clethrionomys rutilus* in collections from tundra and taiga east of the Mackenzie River Delta, Northwest Territories. Sample sizes are in parentheses

Location, date	Over wintered	Early-cohort	Late-cohort	All ages
Taiga				
May–October 1971	0.0 (147)	0.0 (123)	1.6 (317)	0.9 (587)
1972	0.4 (225)	2.9 (137)	2.2 (229)	1.7 (591)
1973	0.8 (128)	6.9 (87)	2.1 (243)	2.6 (458)
1971–1973	0.4 (500)	2.9 (347)	1.9 (789)	1.6 (1636)
Tundra				
June–October 1971–1973	0.0 (97)	0.0 (340)	0.0 (534)	0.0 (971)

phase individuals in the population ($0.1 > P > 0.05$), suggesting that the incidence of the dark phase is not influenced by population density. Overwintered voles, however, showed a significantly lower frequency of the dark phase than did young-of-the-year (overwintered vs. early cohort $0.01 > P > 0.001$; overwintered vs. late cohort, $0.05 > P > 0.01$). Overwintered animals examined were 8–16 months old and probably contained a higher proportion of faded individuals, which were not recorded, than young-of-the-year which were less than 5 months old.

Manning (1956) reported that only 0.8% of the skins he examined were dark-phase. Considering only Manning's collections from the Mackenzie Delta area, however, dark-phase voles comprised 1.9% of his 107 taiga specimens, not significantly different ($0.9 > P > 0.5$) from the 1.6% found in this study, and none of his tundra specimens were dark-phase. There was also a total absence of the dark phase in my tundra sample. The difference in incidence of the dark phase between tundra and taiga is significant ($P < 0.001$). That suggests that selection against the dark phase (at least proteus homozygotes) was greater on the tundra than in the taiga.

Peterson (1966) noted that the dark phase occurs throughout the range of *C. gapperi* but "is apparently clinal, becoming increasingly common in the more northern latitudes." Because of this trend and knowledge of the relation between humidity and darkening factors in other mammals, Zimmerman (1961) suggested a positive selective value of the proteus gene in areas with increased humidity. But the incidence of the dark phase in *C. rutilus*, the more northerly species in North America, appears much lower than that for northern populations of *C. gapperi* (cf., Harper 1956, 1961; Preble 1908; Smith and Foster 1957). Also the dark phase is extremely rare or absent in at least some tundra populations of *C. rutilus*. That suggests either that selective factors other than humidity are oper-

ating on proteus or that the selective factors are different for *C. rutilus* than for *C. gapperi*.

One pregnant, apparently red-phase, overwintered *C. rutilus*, live-trapped near Inuvik, gave birth in the laboratory to three red-phase (1♂, 2♀♀) and two dark-phase (1♂, 1♀) young. One dark-phase young died at 19 days of age and the second at 42 days of age, but the three red-phase individuals were still healthy more than 1 year later. The three red-phase young were cross-mated but none of the 18 F1 young produced were dark-phase. The F1 young were cross-mated and were mated with their parents but none of the 28 young produced were dark-phase. That indicates that although the original female captured was a heterozygous proteus, none of the red-phase offspring contained the proteus gene. Those observations are in accord with Zimmerman's (1961) findings that both homozygous and heterozygous proteus have a dark dorsal stripe at birth and in their first subadult coat.

In addition to the proteus individuals, two apparently heterozygous agouti late-cohort *C. rutilus* were taken near Inuvik in January 1972 and August 1972. (The former was taken in additional winter collections by the author.) One tundra population (Tununuk Point: 69°00' N, 134°40' W) contained a new color phase. Individuals were of normal color except for the lower back and rump where the tips of many of the guard hairs were sepia. The coloring was similar to the heterozygous agouti individuals but was much less intense. The tundra population was trapped in September and October 1972 and in September 1973, and dark-rump voles were taken in all three samples. In total, 20 overwintered, 95 early-cohort, and 267 late-cohort individuals were examined. None of the overwintered or early-cohort animals were dark-rumped, but six of the late-cohort animals were dark-rumped and two others had dark guard hairs on the upper back and sides as well. Those latter two

individuals still had much less intense coloring than agouti animals. The dark-rump color phase may be similar to the "blackish" color phase found by Harper (1961) in *C. gapperi* in central Ungava Peninsula.

The dark phase (proteus) in *Clethrionomys* deserves further attention as a genetic marker because of its obvious phenotype. Such a natural marker could be used to measure changes in the genetic composition of populations between years, particularly in northern *C. gapperi* populations where 25% or more of the animals may be proteus.

I am indebted to T. H. Manning for bringing Zimmerman's paper to my attention and for his comments on the manuscript.

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First Record of Atka Mackerel, *Pleurogrammus monopterygius* (Hexagrammidae), in British Columbia

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Pleurogrammus monopterygius (Pallas) is a mid-water greenling (Hexagrammidae) of commercial and sporting value in Soviet (Ruttenberg 1954) and Alaskan waters (Evermann and Goldsborough 1907; Scheffer 1959). Although usually called Atka mackerel (Miller and Lea 1972, p. 116; Quast and Hall 1972, p. 19), a name recognized in the American Fisheries Society's, *A List of Common and Scientific Names of Fishes* (Bailey et al. 1970, p. 57), the name forktail greenling appears in recent literature (Fitch and Lavenberg 1973, p. 131). Previous known distribution for the species is from southeastern Alaska to the Yellow Sea and Sea of Japan (Quast and Hall 1972) and Monterey, California (Miller and Lea 1972). Although its occurrence in British Columbia was expected, there are no documented records. Even though abundant in parts of its geographic range, adequate numbers of specimens for meristic studies are lacking in North American museums (Quast 1964).

On 24 August 1976 a specimen 126 mm in standard length was captured after an overnight set of experimental gill nets at the south end of Hunger Harbour, Tasu Sound, Queen Charlotte Islands (52°45'12" N, 132°01'23" W) by staff of the British Columbia Provincial Museum. The nets were 1.8 m (6 ft) in height and were fished on the bottom between 12.2 m (40 ft) and 36.6 m (120 ft) below 0 tide level. Identification was based on its unnotched dorsal fin, forked tail, and five separate lateral lines. There are 20 spinous dorsal, 26 soft dorsal, 24 anal, and 25 pectoral fin rays on the specimen. The second lateral line had 149 pores and another 16 on the caudal fin. The first, second, and fifth lateral lines terminated posterior to the caudal peduncle. The third lateral line terminated above the 18th anal ray and the fourth ended opposite the tip of the depressed pelvic rays; however, there was a tendency for the fourth to merge with the fifth lateral line on the left side rather than overlap the third as illustrated by Ruttenberg (1955). This specimen

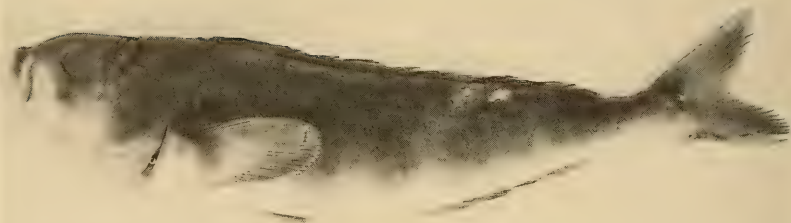


FIGURE 1. The first specimen of *Pleurogrammus monopterygius* (BCPM 976-1389) from Canadian waters.

(British Columbia Provincial Museum catalogue number BCPM 976-1389) is illustrated in Figure 1 and provides the first published record of Atka mackerel for British Columbia waters.

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Apparent Distraction Display by a Barred Owl

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On 18 June 1976 we were searching a section of mixed hardwood forest in Hudson, Quebec for the nest and young of a pair of Barred Owls (*Strix varia*). As we approached the nest vicinity, the female owl, identified by her higher-pitched voice as compared to that of the male heard on earlier occasions, made her presence known to us by emitting calls described by

Eckert and Karalus (1974) as "hoo - hoooo hoo-WAAHHHHhhh, gradually fading away." She appeared relatively unafraid and remained perched about 20 m high in a beech tree (*Fagus grandifolia*) maintaining a close watch on us. The male, however, was not observed on this date. Shy versus aggressive behavior towards intruders in the nest area appears to

vary with individual birds (Dunstan and Sample 1972; Eckert and Karalus 1974).

On four occasions during our half-hour search, the female glided downward, distances ranging from 20 to 60 m, to alternate perches about 3 to 6 m high in other trees partially hidden from our view by foliage. Immediately upon landing on the perch either facing us or facing away, she spread and quivered both wings and simultaneously uttered a series of chitters and squeals resembling those generally made by begging young. This behavior lasted only 5 to 10 s, after which she crouched on the branch with her wings kept partially opened. When we approached within 20 m of her, the owl returned to one of several high perches located in a central area of roughly 2500 m².

Although we are both experienced field observers, we were fooled on the first two occasions into thinking she had led us to a nest of young or to one of her fledglings begging for food. An intensive search of the area surrounding these perches revealed neither of these and thereafter we restricted our search to the central area. The following day three young Barred Owls were discovered perched high in the trees in the same area occupied by the adult female the previous day.

Injury-feigning displays designed to draw intruders away from young have been cited by Bent (1938) for

Great Horned Owls (*Bubo virginianus*), Snowy Owls (*Nyctea scandiaca*), Long-eared Owls (*Asio otus*), and Short-eared Owls (*Asio flammeus*), but these displays have never been reported for Barred Owls (M. Fuller, T. Dunstan, personal communication).

Of further interest here, however, is that the distraction display was not of an injury-feigning nature, but appeared to simulate the feeding of a young bird by the parent. One other distraction display is reported by Eckert and Karalus (1974) for the Long-eared Owl, that is that the parent attempts to draw intruders away from its young by noisily pretending to catch and kill "some kind of bird as prey." Only additional observation on distraction displays on any owl species can serve to clarify these behavioral phenomena.

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Natural History of Rock Voles (*Microtus chrotorrhinus*) in Minnesota

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Abstract. A population of rock voles, *Microtus chrotorrhinus*, which inhabited a large bed of boulders in northeastern Minnesota, was studied in August 1975. The voles did not occupy the entire boulder field, but rather appeared to be restricted to a narrow transition zone between the open rocks and mature forest. An interconnecting system of runways was found in the crevices beneath and between the boulders. Litter size averaged 3.5, with some females producing at least three litters during the breeding season. Females born in late spring produced litters during their first summer. Notes on food habits, activity, parasites, cranial measurements, and associated species are included.

The rock vole, *Microtus chrotorrhinus*, occurs from the Ungava Peninsula to the southern Appalachian Mountains, and west along the northern shores of the Great Lakes to Minnesota (Hall and Kelson 1959). Rock voles are restricted to moist rocky habitats in the Canadian and Hudsonian life zones (Kirkland 1977; Linzey and Linzey 1971; Martin

1971a; Doult et al. 1973; Timm 1974), or more rarely to openings in moist forest (Goodwin 1929; Kirkland 1977). Prior to this study, the rock vole was known in Minnesota from one specimen taken in 1921 near Burntside Lake, St. Louis County (Swanson 1945; Handley 1954), and two taken in 1973 in Cook County (Timm 1974).

Study Area and Methods

The study area was a long, narrow boulder field, approximately 1.2 km long and 120 m wide, located in sections 19, 20, and 29 of T. 64 N, R. 1 E, Cook County, Minnesota. This open boulder field crosses County Road 12 at 27 km N and 2 km W of Grand Marais, Minnesota, and lies at an elevation of approximately 540 m in a broad valley between two low hills. Frost action associated with retreat of glaciers from this area approximately 9000 years BP (Before Present) is thought to have been responsible for the development of the bed of granophyre and gabbro boulders. Timm (1975) summarized details of climate, vegetation, and mammals in Cook County.

The center of the boulder field consisted of exposed rocks occasionally interspersed with small "islands" of shrub vegetation. Dominant vegetation in open rock areas consisted of dry lichens and reindeer moss (*Cladonia*). The forest surrounding the rock bed was dominated by aspen (*Populus tremuloides*), paper birch (*Betula papyrifera*), and black spruce (*Picea mariana*). Young balsam fir (*Abies balsamea*) also was common. Thimbleberry (*Rubus parviflorus*), Clinton's lily (*Clintonia borealis*), bunchberry (*Cornus canadensis*), wild lily-of-the-valley (*Maianthemum canadense*), and large-leaved aster (*Aster macrophyllus*) were the most common herbs. The transition zone between open rocks and forest, ranging from 5 to 10 m in width, was dominated by woody vegetation from 1 to 3 m in height. Especially common in this zone were alder (*Alnus*), willow (*Salix bebbiana*), honeysuckle (*Diervilla lonicera*), serviceberry (*Amelanchier*), and young balsam fir. Several small plants, especially rose (*Rosa acicularis*), blueberry (*Vaccinium angustifolium*), Clinton's lily, bunchberry, wild lily-of-the-valley, twin-flower (*Linnæa borealis*), and black spruce were common. Boulders covered with moss and leaf litter extended well into dense forest, indicating that the size of the open boulder field has diminished with vegetational succession. Standing water was visible under a small part of the boulder field.

Two hundred museum special mouse-traps and 50 Sherman live-traps were baited with peanut butter and oatmeal, and checked four times daily 8–12 August 1975. The 24 rock voles and representatives of all other species trapped were prepared as study specimens and deposited in the Bell Museum of Natural History, University of Minnesota (MMNH).

Results and Discussion

Habitat Selection

All rock voles taken during this study were captured in the boulder field; nearly all were captured in the transition zone between open rocks and mature forest.

Within this zone most were trapped below the rock surface in cavities between boulders. These cavities were partially filled with soil and were connected to the rock surface and to each other by runways. The southern red-backed vole, *Clethrionomys gapperi*, was the only other small mammal captured in subsurface runs. The pronounced preference of rock voles for the transition zone probably was due to availability of both preferred food and nesting sites. The subsurface environment presumably assisted in avoidance of both predators and extreme weather conditions. One trap set about 25 cm below the surface captured three adult rock voles, indicating multiple use of runways.

Reproduction

Eleven of 13 adult and subadult females were active reproductively; at least two of these were young-of-the-year as indicated by body size and cranial characters. A mean litter size of 3.5 ($N=13$) was estimated from counts of embryos, corpora lutea associated with unimplanted embryos, and recent placental scars (see Table 1). These results are similar to data presented by Martin (1971a) and Coventry (1937), who found mean litter sizes of 3.7 and 3.6, respectively.

Proportionately fewer males than females in our sample were sexually active. Four of the 11 males trapped were in breeding condition as judged by size of the testes and development of the epididymides and seminal vesicles. Average length and width of the testes of these four animals were 12.8 and 7.5 mm, body weight ranged from 32.7 to 43.7 g, and the smallest specimen was 150 mm in total length. The seven non-reproductively active males (testes length \times width $\leq 5 \times 3$ mm) varied in weight from 16.2 to 24.8 g. None had a total length greater than 150 mm.

Timm (1975) reported that deer mice, *Peromyscus maniculatus*, southern red-backed voles, and meadow voles, *Microtus pennsylvanicus*, started breeding in Cook County in May of both 1972 and 1973 and that females of the latter two species may have three litters during the summer. Evidence of three pregnancies (see Table 1) in two large female rock voles in our sample indicated that May or June also may be a typical time for initiation of breeding by rock voles at this locality.

Food Habits

Most blueberry bushes (both leaves and stems) and Clinton's lily plants along the narrow margin of the boulder field where rock voles were trapped were heavily browsed by rodents, as indicated by tooth marks. A smaller proportion of wild lily-of-the-valley, bunchberry, and mushrooms appeared to have been

TABLE 1—Reproductive characteristics of 11 subadult and adult female rock voles from Cook County, Minnesota, collected in August of 1973 and 1975. Code abbreviations are as follows: embs (embryos), CL (corpora lutea associated with unimplanted ova), RS (recent placental scars), OS (old placental scars), L (left uterine horn), R (right uterine horn). Animals are listed in decreasing order of size

Catalog number	Total length (mm)	Weight (g)	Number of pregnancies	Litter size	Comments
12266	160	33.0	2	3RS (1L×2R) 4OS (2L×2R)	Trapped from same locality in August 1973
12996	158	46.0	3	4CL (1L×3R) 5RS (4L×1R) 5OS (2L×3R)	
12986	156	40.0	3	CL (unknown #) 3RS (2L×1R) 6OS (3L×3R)	Well developed mammary tissue
12985	152	34.9	2	3CL (2L×1R) 4RS (2L×2R)	Lactating
12979	152	26.5	2	4 embs (3L×1R) 4OS (2L×2R)	
12998	147	39.5	2	4 embs (3L×1R) OS (unknown #)	CL associated with embryos = 2L×1R; thus, possibly a case of polyembryony
12982	147	28.3	2	3CL (3R) 3OS (2L×1R)	Well developed mammary tissue
12997	146	36.4	2	3 embs (2L×1R) OS (unknown #)	1 resorbing embryo L
12978	145	—	2	3 embs (1L×2R) 5OS (4L×1R)	Well developed mammary tissue
12983	143	29.6	1	3RS (2L×1R)	Well developed mammary tissue
12981	133	19.1	1	3CL (1L×2R)	

browsed. Grass was less common and showed little evidence of being grazed. Three rock voles carried plant material in their mouths when captured; one had the partial leaf of a forb, one carried two seeds and a bud, and the third was carrying 3- to 5-cm clippings of fresh grass. Captive rock voles consumed blueberry (stems, leaves, and ripe berries), leaves of Clinton's lily and wild lily-of-the-valley, bunchberry (leaves and ripe berries), and ripe raspberry (*Rubus strigosus*), but showed little interest in fresh grasses from the site of capture. A captive subadult male readily consumed all insects presented to him, suggesting that the rock vole may be omnivorous rather than strictly herbivorous as previously believed.

Activity Patterns

Goodwin (1929) and Martin (1971a) stated that rock voles are active primarily during daylight hours.

This apparently was not the case during our study: of 21 individuals trapped on 9 and 10 August, 7 (33%) were taken between 2300 and 0700 hours (33% of the day); 4 (19%) between 0700 and 1200 hours (21% of the day); 2 (10%) between 1200 and 1800 hours (25% of the day); and 8 (38%) between 1800 and 2300 hours (21% of the day). Timm (1974) reported capturing one rock vole from this population in the early evening and another in the early morning. Thus, it appears that rock voles are active throughout the day and night, but less active during afternoon hours, at least in northern Minnesota during August.

Parasites

Parasites collected from rock voles during this study include mites, *Laelaps kochi* and *Haemogamasus ambulans* (Thorell, 1872) [= *H. alaskensis* Ewing, 1925]; chiggers (*Neotrombicula microti* and

Neotrombicula harperi); ticks (*Ixodes angustus*); and tapeworms (Cestoda: Hymenolepididae). This record represents the first time *Neotrombicula microti* has been identified as being parasitic on rock voles. Timm (1974) also reported two species of fleas (*Peromyscopsylla catatina* and *Megabothris quirini*) and one species of mite (*Laelaps alaskensis*) parasitizing rock voles at this locality.

Cranial Measurements

Selected cranial measurements (mean and range in millimetres) for four adult females followed by those of four adult males are as follows: greatest length of skull 26.4 (26.2–26.6), 27.1 (26.8–27.4); zygomatic breadth 14.6 (14.4–14.7), 15.1 (14.4–15.6); inter-orbital constriction 3.6 (3.5–3.6), 3.7 (3.5–3.7); length of nasal bones 7.4 (7.2–7.5), 7.6 (7.4–7.9); length of maxillary toothrow 6.2 (5.8–6.4), 6.3 (6.2–6.5). These measurements are larger than corresponding measurements reported by Komarek (1932) for specimens of the same subspecies, *M. chrotorrhinus chrotorrhinus*, from the eastern part of their range.

Associated Species

Nine other mammalian species (followed by the number of each trapped) were taken from the study area in 1975: short-tailed shrew, *Blarina brevicauda* (1); eastern chipmunk, *Tamias striatus* (1); least chipmunk, *Eutamias minimus* (7); red squirrel, *Tamiasciurus hudsonicus* (1); deer mouse (6); southern red-backed vole (48); meadow vole (2); southern bog lemming, *Synaptomys cooperi* (5); and ermine, *Mustela erminea* (1). Timm (1974) also captured the arctic shrew (*Sorex arcticus*), masked shrew (*S. cinereus*), and woodland jumping mouse (*Napaeozapus insignis*) at this site. Several mink, *Mustela vison*, were sighted in the vicinity in 1973 and 1975.

The presence of four species of microtine rodents at this site is of interest in regard to competition and competitive exclusion in small mammals. Martin (1971b) found no reports of the meadow vole in habitat occupied by the rock vole. Our two meadow voles were non-breeding subadult males and were trapped in the open rocks. Breeding populations of meadow voles apparently occur in the area and individuals disperse to the rock outcrops, but meadow voles have not successfully colonized the boulder field.

Five southern bog lemmings were trapped in the transition zone and adjacent mature forest. One of these was removed from a trap at which a rock vole and a southern red-backed vole had been captured previously. The presence of a pregnant adult female suggests a resident population of southern bog lemmings at the site, and indicates at least some overlap of habitat use by bog lemmings and rock

voles. Southern bog lemmings appear to have a broader habitat range, utilizing forest areas as well as the transition zone.

The southern red-backed vole was an abundant small mammal both in the preferred habitat of the rock vole and in the adjacent forest. It was the only other microtine taken from subsurface runs, and in at least three instances was taken from traps that also caught rock voles. In addition to being active at the same time, red-backed voles probably eat many of the same foods, and breeding by the two species takes place during the same times of the year. No fighting occurred in laboratory investigations of behavior using a single subadult male rock vole and three adult red-backed voles, but the rock vole appeared to be dominant. Red-backed voles were aggressive when handled however, whereas rock voles were docile.

Conclusions

The ecology of the rock vole suggests several questions for future investigation. Because all populations of rock voles reported seem to be small and isolated from other populations, it would be especially interesting to examine patterns of genetic variability. What allows rock voles to compete successfully with several other microtine rodents, especially red-backed voles, which appear to occupy a similar niche in this environment? Is their non-aggressive behavior and low litter size a response to a relatively stable and predator-free subterranean living situation? Do they show cyclic patterns of population fluctuation?

The rock vole is rare and remains poorly known in Minnesota. As the forest encroaches upon the rock bed, habitat available for rock voles is slowly decreasing; however, a more immediate threat to the population is destruction of habitat for timber harvest. Steps should be taken to insure that this site is protected and that scientific investigations on this population be conducted in such a manner as not to threaten its future.

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Disorientation in Ringed and Bearded Seals

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The phenomenon of seals lost on land or unable to find access to the water through the frozen ice cover is well documented for some antarctic localities (Stirling and Rudolph 1968; Stirling and Kooyman 1971). Although it is common knowledge among the Inuit that seals get lost, few reports exist of such occurrences for the Arctic. Freuchen and Salomonsen (1958) and Freuchen (1935) note that walrus (*Odobenus rosmarus*) and ringed seals (*Phoca hispida*) sometimes get caught out of the water by freezing ice. This note documents several instances where both live or dead ringed seals and bearded seals (*Erignathus barbatus*) have been found on the land or away from access to water. Data were collected over an 8-year period in the Home Bay region, east Baffin Island, and in the Holman region on the west coast of Victoria Island, Northwest Territories.

Ringed Seals

On the Sea Ice

June 1968. During a hunt of hauled-up seals on the flat ice northeast of Ekalugad fiord (68°40' N, 65°10' W) the trail of a lost seal was found. By following the tracks for approximately 1.6 km over the flat sea ice, we located and collected a ringed seal pup (0+ years).

14 June 1972. A track was followed for at least 6.6 km until

the ringed seal pup (0+) was found on the flat sea ice near Iluvilik (70°30' N, 116°30' W) southeast of Holman, Northwest Territories.

Late April or early May 1973. Approximately 25 km to the west of Holman (70°57' N, 118°25' W) on the shoreline, an adolescent ringed seal was found. The track of the seal was found on the ice, trailing inland for a short distance and then returning to the sea ice. The land at this location rises as a gentle slope from the ocean. This area of shoreline also shows a consistent opening and closing of tidal cracks during the fast-ice season. The seal had apparently been out of the water for some time, since its hindquarters were frozen. The ventral skin surface was badly worn indicating that the animal had travelled a considerable distance. There was some evidence of bite marks in the axilla and on the hind flippers.

On the Land

5 May 1972. A yearling male ringed seal was sighted approximately 18 km inland northwest of Holman (70°47' N, 117°49' W) near Okotitak Lake. The seal was alive and still moving. It had very badly worn areas of skin ventrally. Another seal was found crossing Irkaharvik Lake (70°52' N, 117°56' W) approximately 17 km inland northeast of the village of Holman. The exact year of occurrence is not remembered but the seal was found in late March or early April.

Early June 1973. A live adolescent ringed seal was found approximately 150 m inland on the south shore of Prince

Albert Sound (70°30' N, 116°32' W) near Cape Baring. The condition of the seal indicated it had recently come ashore. The shoreline is very low, and the boundary between sea ice and land, covered by snow, imperceptible to the human eye.

28 August 1973. A whole skeleton of a medium-sized ringed seal was found in a high valley approximately 60 m above sea-level on an island in Prince Albert Sound (70°30' N, 116°30' W). The valley could have been reached from the end of a long crooked inlet penetrating into the island for a distance of approximately 2 km. It is unlikely that the carcass would have been left by the Inuit since no one traps inland on these islands.

Bearded Seal

27 March 1974. A 0+-year-old bearded seal measuring 100 cm nose to tail, 115 cm maximum girth, was found frozen into the surface ice of a lake. The lake was located at 71°10' N, 118°00' W, 52 m above sea-level and connected to Minto Inlet by a small steeply rising creek. In its frozen condition the specimen displayed the "hunched back" posture seen in distressed seals. Its foreflippers were folded ventrally and the hind flippers curled toward each other. The skin on the sternum and the axilla region was worn indicating that the seal had travelled over land or ice. The vibrissae also showed excessive wear. The blubber layer was virtually nonexistent suggesting the seal had not fed well for some time. Examination of the stomach and intestines showed the seal had attempted to nourish itself by eating arctic willow and grasses. A quantity of brown matter, probably earth, was also found. No evidence was seen of fish or invertebrate remains. It is unclear whether the seal had journeyed up to the lake after freeze-up or if it had gone up the river during the open-water season the previous summer.

Discussion

Instances of ringed seals found away from access to water result from seals moving away from their exit holes or being frozen out of the hole or crack they had emerged from.

Both cases of ringed seals found moving over the ice during the period when exit holes no longer freeze quickly involved young-of-the-year (0+ age). Observations of pups still with their mothers during the haul-out period from May through June showed them to move further away from the breathing holes than the adult seal. If visual clues are used to locate the hole it is not surprising that pups frequently become disoriented. At this time of the year, however, a large number of breathing holes and cracks are present so that many of the disoriented pups probably regain access to the water. The air temperatures are also high enough so as not to cause many deaths through freezing.

A different situation exists with adolescent seals (1+ to 6+ years old) found relatively frequently on the ice or the land during the early spring months of March and April. Here loss of access to the water usually results in death. The reasons for the initial emergence

onto the ice, and why the seal becomes frozen out are not at all clear. The presence of bite marks and the often poor nutritional state of the seals may suggest some form of intraspecific competition being involved. Whether this is connected with territoriality or simple competition for food is not known. It is also possible that diseased and sick seals emerge from the water simply to rest and because of their weakened state get frozen out. We have also found several dead adolescent seals inside haul-out lairs under the snow.

The actual movement of seals from the water or sea ice onto the land may be explained in several ways. During the snow-covered period it is very difficult to distinguish visually between the sea ice and the land along low-lying coastlines. If in fact seals are using visual clues as they are trying to relocate a hole or crack, they could easily move onto the land without knowing it.

In the summer open-water period, ringed seals and bearded seals occasionally move into small rivers. In one instance a ringed seal pup (0+ age) was seen swimming up the small Anialik River (70°34' N, 116°57' W). The pup continued to swim into the current even after it had seen me wading out to it from a point upstream. It remained undaunted in its attempt to swim up the river against the strong current until I captured it. Such orientation into the currents of small rivers and movements up these streams might lead to the occasional disorientation and emergence onto the land in ringed seals. Bearded seals in the summer months are known occasionally to haul out onto the land to bask. This habit might also occasionally lead to disorientation inland among the younger inexperienced seals.

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Breeding Status of the Say's Phoebe in Manitoba

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Godfrey (1966) includes southwestern Manitoba in the breeding range of the Say's Phoebe (*Sayornis saya*) on the basis of Taverner's (1927) report of the species nesting several times in the neighborhood of Aweme, which was formerly near Treesbank, as reported to Taverner by Norman Criddle, then of Aweme. There is, however, no reference on file at the Manitoba Museum of Man and Nature, Winnipeg, of the species having nested at Aweme, and moreover the Manitoba Museum Field Check-list of Manitoba Birds (1974) classes the species as of irregular occurrence in Manitoba. Further, Brazier (1956) could find no published record of the bird's occurrence in Saskatchewan farther east than Regina, although it was recorded in open country near Moose Mountain, Saskatchewan in 1959 (Nero and Lein 1971). In this paper, I show that the Say's Phoebe has nested several times in recent years in southwestern Manitoba, and that it is a rare but regular breeding species in the province.

Prior to the 1970s, the only nesting record in Manitoba, apart from those reported by Taverner (1927), was in 1946 at Oak Lake where Herman Battersby (personal communication) located a pair nesting in an old house, the pair raising five young. In 1972 a pair repeatedly tried to nest at the Customs Office on Highway 256, 11 km southwest of Lyleton. The pair finally constructed a nest on the third attempt, but on 19 June the female was found dead beneath the nest, which contained three eggs. The bird is now specimen 3229 in the Manitoba Museum of Man and Nature. In both 1973 and 1974, a pair returned to the same location for the summer, but no evidence of nesting was found, although a family party of five birds on 16 July 1974 indicated a successful nesting somewhere in the immediate area (J. L. Murray, personal communication).

On 26 May 1974, I located a pair of Say's Phoebes at an abandoned farmhouse 7 km southeast of Lyleton, and on 2 June R. F. Koes and I found the nest being built inside a nearby barn. The nest contained five eggs on 21 June, and the pair succeeded in raising at least three young. The nest is now in the Manitoba Museum of Man and Nature, catalogue number 1.21-338.

In 1975 and 1976, Say's Phoebes returned to the farmhouse. No nest was located in 1975, but in 1976 a nest was found on 7 June in an old Barn

Swallow (*Hirundo rustica*) nest, containing four young phoebes, three of which were subsequently reared (personal observations).

Thus, in five consecutive years, Say's Phoebes have bred or have been present through the summer in the vicinity of Lyleton, in the extreme southwestern corner of Manitoba. This part of the province is mixed-grass prairie, arid and hot in summer, with numerous abandoned farms, i.e., one type of habitat Say's Phoebes will inhabit (Bent 1963). Away from this habitat in Manitoba, the Say's Phoebe is very rare: indeed, there are no sight records north of Brandon (Lawrence 1934) and Oak Lake (D. R. M. Hatch, personal communication), nor east of Aweme (Criddle 1913). In adjacent counties in the North-western Drift Plain in North Dakota, the species is classed as uncommon, although several nests with dependent young have been located in the last 20 years (Stewart 1975).

The Say's Phoebe then is a rare but regular breeder in Manitoba, with individual pairs widely dispersed and with probably no more than 10 pairs per year.

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Le Grand Cormoran (*Phalacrocorax carbo*) en Hiver, le Long des Côtes de la Péninsule de Gaspésie, Québec

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Depuis 1974, des recensements annuels réalisés par le Service canadien de la faune le long des côtes de la péninsule de Gaspésie permettent de mieux connaître la distribution hivernale de plusieurs espèces d'oiseaux aquatiques. La présence du Grand Cormoran (*Phalacrocorax carbo*), parmi les espèces inventoriées, ne manque pas d'intérêt puisque sa distribution en hiver est peu documentée et fut considérée jusqu'à ce jour comme inusitée au Parc national de Forillon (Ouellet 1975), bien que Palmer (1962, p. 321) l'ait déjà inclus comme résident d'hiver en Gaspésie. Erskine (1972) a déjà révisé l'aire d'hivernage de cette espèce qui se situe principalement le long des côtes du Maine et du Massachusetts ainsi qu'en quelques concentrations mineures en Nouvelle-Écosse (Ross 1974) et au sud-ouest du Nouveau-Brunswick.

Les données consignées ici (Tableau 1) proviennent d'inventaires réalisés durant la dernière semaine de janvier en 1974 et la première semaine de février en 1975 et 1976. Les conditions climatiques difficiles dans lesquelles les observations de 1974 ont été effectuées, ne nous ont pas permis de distinguer avec satisfaction s'il s'agissait de *Phalacrocorax carbo* ou

P. auritus bien que la présence de ce dernier eût été assez inusitée. De meilleures conditions d'observation en 1975 et 1976 ont permis d'identifier tous les individus comme étant des Grands Cormorans. Il est donc probable que les individus observés en 1974 appartenaient aussi à l'espèce *P. carbo*.

Le nombre maximum de 102 Grands Cormorans obtenu en 1976 est inférieur aux estimés que Ross (1974) a rapportés sur la côte de la Nouvelle-Écosse, soit 390 par un inventaire au sol et 674 par un inventaire aérien. Cependant, nous croyons que le nombre maximum qui apparaît ici pourrait être supérieur si un inventaire aérien était réalisé. Ainsi, à quelques reprises on a vu des individus surgir du rebord de la falaise comme s'il s'agissait d'oiseaux qui quittent un reposoir. Ces endroits ainsi que plusieurs autres sites disponibles pour le Grand Cormoran sont impossibles à inventorier au sol.

En 1976, on a remarqué deux groupes importants qui se reposaient sur le bord de la glace, soit 46 à cap Maria et 44 à Port-Daniel. Cette façon typique de se rassembler a aussi été observée en 1974 et 1975 chez des groupes plus restreints en divers endroits de la côte. Il est à remarquer qu'aucune observation de cette espèce ne fut consignée entre Percé et Cap-des-Rosiers au cours de ces trois inventaires annuels, comme on l'a noté précédemment (Ouellet 1975).

Je remercie Austin Reed et André Bourget d'avoir porté attention à la présente communication.

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TABLEAU 1—Dénombrement du Grand Cormoran le long des côtes de la péninsule de Gaspésie en hiver en 1974, 1975 et 1976

Lieu	1974	1975	1976
Maria	0	16	46
Cap noir à Bonaventure	28	0	0
Hope à Shigawake	25	26	1
Port-Daniel	2	0	44
Newport à Pabos	0	3	5
Grande-Rivière à Cap d'Espoir	1	27	6
Total	56*	72	102

*L'identification du Grand Cormoran n'a pu être certifiée en 1974 en raison des conditions de température inclementes, mais il s'agissait probablement de cette espèce.

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Records of the Boreal Toad from the Yukon and Northern British Columbia

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Logier and Toner (1961, pp. 27–28) list and map Prince William Sound and Yujutat in Alaska and Telegraph Creek, Lake Tetana, Hudson Hope, and Tupper Creek in British Columbia as the northern boundary of the range for the Boreal Toad, *Bufo boreas boreas*. Stebbins (1966, Map 31) apparently followed these points in drawing his northern range limit for the subspecies. Herreid (1963) reported specimens from the Liard Hot Springs about 400 km (250 mi) northeast of the range shown by the above authors.

Unnoted by these authors, however, was a specimen collected between 1 and 10 July 1948, by William Mason at Whitehorse in the Yukon Territory and deposited in the American Museum of Natural History collection (AMNH 54146, 40.3 mm snout-vent length). This is the first record of the species from the Yukon Territory.

Several additional unreported northern records are catalogued in the Herpetology Section collections of

the National Museum of Natural Sciences. A specimen (NMNS 5864, 41.5 mm snout-vent length) from North Toobally Lake (60°21' N, 126°15' W, elevation 660 m (2200 ft) collected by P. M. Youngman and G. Tessier on 16 July 1961 is the only other record of the species from the Yukon Territory. It extends the known range some 80 km (50 mi) north of the Liard locality. The field notes of these collectors indicate that the specimen was taken at their campsite on the east shore of the lake, near its south end. This is only the second amphibian species definitely known to occur in the Yukon. The Wood Frog, *Rana sylvatica*, has been taken at many localities in the territory (Logier and Toner 1961; NMNS collections). One other anuran, the Western Spotted Frog, *Rana pretiosa*, is reported almost at the Yukon border at Lake Bennett (Carl 1943, p. 50) in northwestern British Columbia. A Boreal Toad (NMNS 2170, 71.0 mm) from Mile 46 of the Haines Road (north of Haines, Alaska but in British Columbia) was collected

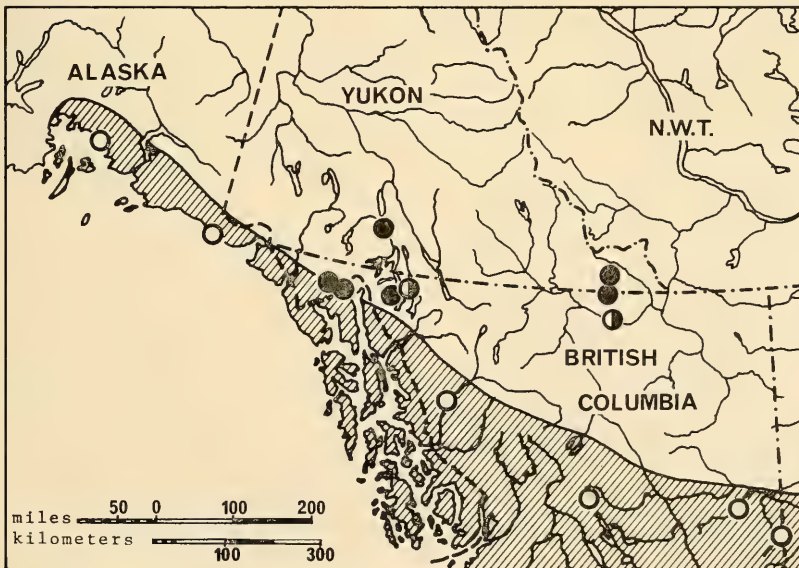


FIGURE 1. Map of known range of the Boreal Toad, *Bufo boreas boreas*, in northern British Columbia, Yukon, and Alaska. The hatching represents the range as depicted by Stebbins (1966); open circles are records shown in Logier and Toner (1961); partly open circles are records given by Herreid (1963) and Cowan (1936); solid circles are new records.

by W. E. Godfrey on 30 July 1949 and is the first record of this species for this northwestern projection of British Columbia into Alaska. Deirdre Griffiths (personal communication, 1973) has provided a sight observation of another at Mosquito Lake Campground, 3.2 km (2 mi) east of Mile 27.2 on the Haines Highway, on 12 July 1972. Overlooked by Logier and Toner (1961) is a record, given by Cowan (1936, p. K19), from Atlin near the Yukon border in western British Columbia.

Hugh S. Bostock (personal communication to J. S. Bleakney, NMNS files, 1952; and to FRC, 1972) reported that toad eggs were observed to be abundant in pools on the south side of Willison Bay (134° 10' N, 59° 15' W), Atlin Lake 6 to 8 July 1952. Numerous tadpoles were seen in these ponds at this locality during this time. He was informed that toads also inhabit the area around the warm spring (at Warm Bay) (133° 30' N, 59° 22' W) about 20 km (12 mi) by road south of the town of Atlin, on the east side of Atlin Lake. Ben-My-Cree (134° 29' N, 59° 19' W) on Tagish Lake, a few miles northwest of Willison Bay is a similar indentation into the Coast Mountains and would seem likely to be in the range of these toads as it too is a sheltered area where snow comes early in the fall and accumulates to depths of 6 m (20 ft) and more. In view of these records *Bufo boreas* should be looked for in the western portion of the Yukon as well.

Three additional unreported collections are from the Liard Hot Springs area. NMNS 2070 (four specimens: 69, 68.5, 67, 52.5 mm) was taken at "Liard River and Alaska Highway, mi. 213 N. of [Fort] Nelson, B.C." by A. L. Rand on 13 August 1943. NMNS 2077 (two specimens: 21.0, 16.5 mm) was taken at "Mile 213, Tropical Valley, Alaska Highway, B.C." also by A. L. Rand on 2 June 1944. NMNS 6513 (three specimens: 60.5, 58.0, 54.5 mm) was taken at the Liard Hot Springs by S. D. MacDonald on 31 May 1962. These specimens predate the three specimens taken 4 September 1962 by Herreid (1963) from this area and substantiate a natural population in the area.

One additional collection falls between the Liard locality and the record from the Yukon. NMNS 5863 (67 mm) was taken at "Smith River," British Columbia, by P. M. Youngman and G. Tessier on 9 July 1961. Field notes indicate these specimens were collected near the Smith River airport.

All of these northern records seem associated with valleys which probably accumulate an early deep snow cover which prevents deep frost penetration and assures safe terrestrial hibernation. Bostock (personal communication) has informed me that at Ben-My-Cree on Tagish Lake the snow cover reached 6 m (20 ft) or more and that there appeared to be no permafrost. He has cited an occasion when the owners

(Mr. and Mrs. Partridge) of the Ben-My-Cree homestead left their vegetables in their garden over winter in the ground and the next spring found their potatoes and other roots had not frozen at all. Although many records are often from the vicinity of hot springs, Deirdre Griffiths' (personal communication, 1973) points out that the individual she observed at Mosquito Lake was frequenting a little spring used for the camp water supply. Water from this spring was very cold.

It is reasonable to suggest that *B. boreas* may have continuous populations connected through favorable valleys in the northern portion of the range. It may be unnecessary to postulate as Herreid (1963) did, that the Liard population is considerably separated from its nearest neighbor and ascribe survival solely to conditions induced by the presence of hot springs, as heavy early snow accumulation and lack of permafrost may be equally important.

Acknowledgments

My gratitude to the several collectors who have deposited specimens in the Herpetology Section, to C. G. van Zyll de Jong for making the field notes of A. L. Rand, P. M. Youngman, and G. Tessier available to me from the files of the Mammalogy Section, National Museum of Natural Sciences, to Richard G. Zweifel, Department of Herpetology, American Museum of Natural History for loaning the specimen from Whitehorse (examined 17 February 1977), and to Deirdre Griffiths for observations. Special thanks are due to Hugh S. Bostock, formerly of the Geological Survey of Canada, now retired, who contributed stimulating observations and comments and suggested important changes in an earlier version of this manuscript. James A. Johnston, Herpetology Section, NMNS, prepared the map.

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Predatory Behavior by Common Grackles

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On 17 July 1975 I received a call from a worried neighbor in Guelph, Ontario, who was concerned over the number of mutilated House Sparrow (*Passer domesticus*) carcasses she was suddenly finding close to her bird feeders. In most cases the carcasses were beheaded and the skin torn from around the shoulders, but in a few instances the head was still attached to the body, the skull was open and the brain removed.

A watch was immediately set at the feeding station, which at this time of year was frequented mainly by House Sparrows, Starlings (*Sturnus vulgaris*), and the Common Grackle (*Quiscalus quiscula*). During the first day of observation a male grackle was seen to attack a House Sparrow that was feeding on the ground with some other sparrows. As the other birds flushed, the grackle knocked the victim to the ground, held it there and repeatedly pecked at the sparrow's head. The sparrow was quickly killed, the cranium opened, and the brains eaten. Thereupon, the grackle paid no further attention to the mutilated carcass and flew off, leaving the body. Following this attack food was withdrawn from the feeding station and no further reports of killings were received. Because of the concern of my neighbor, no attempt was made to trap and mark the grackles involved.

Although not verified, it is possible that all the killings were the act of a single bird, since 15 sparrows had been killed in the same fashion during an 11-day period. Mayfield (1954) observed a grackle killing a House Sparrow in the fashion described above and discovered a headless carcass nearby, and Gross (1958) reports several instances of predatory behavior by individual grackles. Thus the development of predatory behavior by individual Common Grackles, particularly when prey is abundant and can be easily captured, may be more common than suggested by the isolated reports elsewhere in the literature (see Laporte 1974).

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The Function of the Bark Call of the Red Squirrel

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Alarm calls that may warn other members of the same species of the presence of potential predators have been reported for several mammalian species; these include *Cynomys ludovicianus* (King 1955), *Spermophilus paryii* (Melchior 1971; Carl 1971), *Ochotona princeps* (Markham and Whicker 1973), *Alces alces* (De Vos 1958), and others. An alarm function of such calls is well documented for several species, but is still conjectural for others.

Calls of the red squirrel (*Tamiasciurus hudsonicus*) have been described previously by Klugh (1927),

Smith (1963, 1968), Embry (1970), and Nodler (1973); the last two authors have discussed the function of several vocalizations. The commonly heard "scolding" or "bark" call of the red squirrel has been classified as an alarm call by Smith (1963) who felt that the call served to warn others of predators. Nodler (1973) proposed a less specific purpose for the call; she stated that it was a call of stress or release from a stressful situation.

While I was studying the aggressive behavior and population dynamics of red squirrels in interior

Alaska, 10 encounters by red squirrels with avian and mammalian predators were observed. An additional seven encounters have been related to me or reported in the literature. The vocal reactions of squirrels to predators help to clarify the function of the bark call of the red squirrel. Table 1 presents a summary of the vocal behavior of red squirrels during the 17 predator-prey interactions.

In 10 of the 17 encounters (59%), the squirrel's initial response was to remain quiet. Only after the potential predator left did these squirrels give the bark (9 of 10 instances). In five cases the squirrels gave a bark initially; three of these involved a marten. The remaining two cases involved squirrels attacked away from cover by Goshawks. The reactions of the squirrels attacked by Goshawks were similar, and involved fleeing to cover while giving a "rapid squeak" call (a series of high-pitched, rattled notes approximating a succession of barks).

Neighboring squirrels never responded with a bark to the bark of another squirrel that had been attacked by a predator, nor did the movement of a predator elicit the bark from squirrels within its path. It appeared that when a squirrel was seriously threatened by a predator it was quiet. After the predator left the bark was commonly used, but did not appear to be a specific call of alarm since the squirrels that would have been warned by such a call had already been exposed to the predator.

In order to test the response of red squirrels to the bark, I conducted 14 playback experiments using recorded barks. Squirrels responded with bark and "chir" calls (see Klugh (1927) for a description of the chir call) when the speaker was located within 20 m of the midden (four of five). When the speaker was 20 to

30 m away, squirrels tended to give the rapid squeak and chir calls (four of five). When the speaker was beyond 30 m, squirrels gave no vocal response (four of four). In contrast, chir-call playbacks (Searing 1975) frequently elicited chir calls from squirrels when played more than 30 m from the midden. But the fact that the bark elicited a chir call from squirrels when played within 30 m of a squirrel's midden leads me to believe that this call may contain some aggressive components.

It is my impression that the bark is given more frequently when squirrels are not at peak aggressive levels (i.e., during winter) and during moderately aggressive encounters. It is also significant that the chir, an aggressive call (Searing 1975), is given to intruding people, i.e., potential predators. Here again the squirrel usually remains quiet until after the intruder has left, whereupon it usually gives a chir call or less frequently the bark. The fact that these two calls are often used in similar situations further supports my conclusion of a partially common function.

Balph and Balph (1966) reported that the aggressive calls of Uinta ground squirrels (*Spermophilus armatus*) were also used in response to predators and evoked general alertness by all squirrels. My experiments with playbacks of the bark did not yield alert responses by red squirrels.

Nodler (1973) stated that the bark was used by subordinate squirrels during border disputes but never by the dominant individual. She also described situations in which it appeared that squirrels emitted a bark out of frustration. Dollard et al. (1939) suggested that frustration is closely related to aggression.

It appears, therefore, that the bark is an aggressive

TABLE 1—Vocal responses of red squirrels to predators*

Predator	Response of red squirrel						
	While predator present:	Quiet	Quiet	Bark	Bark	Bark	Rapid squeak
	After predator left:	None	Bark	Quiet	Bark and Chir	?	Bark
Goshawk			4				2
Red-tailed Hawk				1			
Unidentified hawk			3				
Great Horned Owl						1	
Hawk Owl	1						
Marten			2		3		
Total		1	9	1	3	1	2

*Includes observations from Klugh (1918), Krasnowski (1969), Klassen (unpublished), Wetmore (personal communication), and the present study.

call of lesser intensity than the chir call rather than an alarm call as previously suggested.

Field work was conducted through the Department of Wildlife and Fisheries, University of Alaska. I thank Steve MacLean, University of Alaska; John Kelsall, Canadian Wildlife Service; and Fred Zwickel and Martin McNicholl, University of Alberta, for critically reading this manuscript and offering their constructive advice and criticism. I also thank Tom Wetmore, University of Alaska, for relating his observations to me and allowing me to cite them.

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Predation on Nesting Glaucous-winged Gulls by River Otter

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Although there is evidence that birds constitute a small portion of the diet of the river otter, few cases of predation upon nesting seabirds have been recorded (Harris 1968). During the summers of 1967, 1970, and 1973 direct and indirect evidence of predation on nesting Glaucous-winged Gulls (*Larus glaucescens*) was observed on Mitlenatch Island, British Columbia (49°57' N, 125°00' W). A description of the island is given by Butler (1974).

The river otter (*Lutra canadensis*) is an abundant animal along the coastal shorelines and offshore archipelagos of British Columbia (Cowan and Guiguet 1965). Since 1963, naturalists have lived on the island during the summer months and have observed river otters each year. Usually, individual or pairs of adult otters were sighted. In 1966, 1968, 1970,

and 1973, however, young otters were also observed. During most summers only between 2 and 10 sightings of otters were made and only rarely were otters seen in the gull colony. Occasionally, single gull carcasses were found that appeared to have been dismembered. An actual observation of river otter predation was made in 1967 (Kennedy 1968). On 7 August an adult otter entered the gull colony, caught a young Glaucous-winged Gull by the back of the neck, and dragged the bird, its wings still flapping, into some dense bushes. In 1970 and 1973 additional evidence of apparent predation by river otter was found.

On 30 June 1970 eight partially eaten adult gulls were found in a heavily trampled area among dense shrub, about 4.5 m (15 ft) in diameter. Otter feces were present and a trampled path led to the water.

During July otters were seen almost daily in the gull colony. Most sightings occurred between 1600 hours and sunset. Excited gulls were often heard at night, perhaps indicating continued otter activity. On 1 August two otters were observed eating a freshly killed gull hatchling. Twelve recently killed young gulls were found on 3 August in another area of approximately 36 m² (400 ft²).

During 1973 an otter was observed in the seabird colony as early as 6 June and gull carcasses were found by 9 June. On 30 July we saw an otter in the colony killing a week-old chick. Most dead gulls had their legs removed and teeth marks were evident in the head region. Most of the gulls were not eaten, indicating that surplus killing was taking place (Kruuk 1972).

In 1973 some areas of the colony that afforded easy access from the water incurred extensive predation. On "F" Island, a small sub-island of 1.9 ha connected to the main island at low tide, approximately 250 Glaucous-winged Gulls were banded each summer, until 1973. On 27 July 1973 only two birds were banded, although a previous nest count of 26 June revealed 286 active nests. During this time interval dead young gulls were found scattered over "F" Island, all showing signs of otter predation. A recheck on 7 August again located only the two previously banded birds. On the "East Hill" area of the main island, only 60 young gulls were banded in 1973, compared to approximately 350 banded annually in previous years. Again, prebanding nest counts indicated little change in the number of active nests from previous years. Other areas of the colony experienced predation to a lesser degree. The steep cliffs along the south shore of the island were visited by predators where access from the water was available through crevices in the rocks.

Although some of this evidence is circumstantial, it does indicate that the river otter is the probable predator of nesting Glaucous-winged Gulls. No other

predators, such as mink (*Mustela vison*), have been observed on the island. During the summer of 1974, similar observations were made on Colville Island in Washington State (Hayward et al. 1975). On several occasions a single river otter was observed taking Glaucous-winged Gull chicks. The remains of adult birds, some dismembered, with their viscera eaten away, were found.

The fact that uneaten gull carcasses were found on Mitlenatch Island makes it difficult to say to what extent the Glaucous-winged Gull makes up the summer diet of the river otter. As the gull colony on the island consists of approximately 2800 breeding pairs (Butler 1974), predation by the river otter would probably not seriously affect the colony size, unless a great deal of surplus killing occurred over an extended period of time, or an increased number of otters utilized this potential summer food source.

We are grateful for the helpful criticisms of R. Wayne Campbell and N. Verbeek.

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Prey Utilized by Urban Merlins

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Merlins (*Falco columbarius*) have nested regularly in the city of Saskatoon, Saskatchewan, since 1971. In 1974, an attempt was made at one nest site to determine the species composition of prey taken.

From this study, it was estimated that 90% of the prey consisted of House Sparrows (*Passer domesticus*), the most abundant small bird in the area (Oliphant 1974). A more detailed study of prey utilization was

undertaken at two urban nests during 1975 to supplement the data gathered the previous year and to allow comparisons with observations made on prairie-nesting Merlins.

Methods

During the breeding season, prey remains, consisting primarily of flight feathers, feet and heads, were collected from under plucking perches near nest sites. The University of Saskatchewan Biology Department study skin collection was used to confirm identification. Sometimes prey was identified by direct observation with binoculars as it was brought to the nest site by the male or as it was being eaten by the female or fledglings. Observations and collection of remains were made on an almost daily basis from mid-June through mid-July in 1974. During 1975, two nest sites were visited nearly every day during May and June. Occasional observations and collection of prey remains were also made during March and April.

Both of the nest sites (one site studied in both years) were situated adjacent to residential areas with open park-like areas nearby. The nest site studied both years was located on the University of Saskatchewan campus. The hunting territory of the male included adjacent residential areas and the agricultural plots and livestock areas of the university. The other nest was in a cemetery in town. The hunting territory of this male included the cemetery and adjacent residential and semi-industrial areas.

Limited data was also collected on prey taken by urban Merlins outside the breeding season. This included observations on immature Merlins soon after they had become independent of their parents (including two groups of young fledged from an artificial nest), wintering Merlins, and observations on the hunting success of a single trained Merlin.

Results and Discussion

During the breeding season, nearly all hunting is done by the male, and birds were the only recorded prey species. Of the total sample of prey, 8% could not be identified for certain. These were all sparrow-sized birds observed through binoculars only. The majority are presumed to have been House Sparrows.

House Sparrows accounted for 69% of the 162 prey items that were definitely identified. Three other species, Horned Lark (*Eremophila alpestris*), Bohemian Waxwing (*Bombycilla garrula*), and Robin (*Turdus migratorius*) accounted for an additional 14%. The remaining 15 species (17%) were recorded less than 5 times each (Table 1).

The prey species were not utilized randomly, primarily because most of the species are not uniformly available throughout the breeding season.

TABLE 1—Prey species utilized by urban nesting Merlins

Species	Number of individuals	% of total
House Sparrow (<i>Passer domesticus</i>)	112	63.6
Unidentified sparrow-sized birds thought to be <i>Passer domesticus</i>	14	8.0
Horned Lark (<i>Eremophila alpestris</i>)	10	5.7
Bohemian Waxwing (<i>Bombycilla garrula</i>)	7	4.0
Robin (<i>Turdus migratorius</i>)	6	3.4
Cedar Waxwing (<i>Bombycilla cedrorum</i>)	4	2.3
Dark-eyed Junco (<i>Junco hyemalis</i>)	3	1.7
Swainson's Thrush (<i>Hylocichla ustulata</i>)	2	1.1
Ruby-crowned Kinglet (<i>Regulus calendula</i>)	2	1.1
Red-eyed Vireo (<i>Vireo olivaceus</i>)	2	1.1
Song Sparrow (<i>Melospiza melodia</i>)	2	1.1
Lapland Longspur (<i>Calcarius lapponicus</i>)	2	1.1
Chestnut-collared Longspur (<i>Calcarius ornatus</i>)	2	1.1
Tree Swallow (<i>Irodoprocne bicolor</i>)	2	1.1
Flycatcher (<i>Empidonax</i> sp.)	1	0.6
Hermit Thrush (<i>Hylocichla guttata</i>)	1	0.6
Western Meadowlark (<i>Sturnella neglecta</i>)	1	0.6
Savannah Sparrow (<i>Passerculus sandwichensis</i>)	1	0.6
White-throated Sparrow (<i>Zonotrichia albicollis</i>)	1	0.6
Lincoln's Sparrow (<i>Melospiza lincolni</i>)	1	0.6
Total	176	

Bohemian Waxwings were recorded only in March, April, and early May. This species generally leaves the Saskatoon area by early May. Only two species, Bohemian Waxwings and House Sparrows, were recorded during April. The diversity of prey species was greatest in May with 15 species recorded. This coincides with the height of passerine migration in the Saskatoon area. In contrast, only eight species were recorded in June with three species (House Sparrow, Horned Lark, and Robin) making up over 90% of the prey items. The percentage of House Sparrows taken steadily increased from 40% in April to about 80% in

June and July. This tendency may account for the very high percentage of sparrows recorded in 1974 since prey items were only recorded from mid-June through July.

Although not recorded as a definite prey item, Common Flickers (*Colaptes auratus*) were unsuccessfully pursued on at least two occasions and old remains of this species were found near one nest. Lawrence (1949) found remains of a Flicker in the nest of a Merlin in Ontario and non-breeding Merlins have been recorded pursuing Flickers (Fox 1964; W. Harris, personal communication).

The prey species utilized by urban nesting Merlins differ considerably from those reported for prairie-nesting individuals of the same subspecies (*richardsonii*). Remains found in nests near Kindersley, Saskatchewan, consisted of 53.5% Horned Larks, 13.6% Chestnut-collared Longspur, 13.3% Cowbird, and 20.1% native sparrows (Fox 1964). Similarly, Hodson (1976) found that Horned Larks accounted for 50% of the prey, Chestnut-collared Longspurs 37%, native sparrows 2%, blackbirds 4%, and other species (including unidentified) 7%. This was computed from 2070 prey remains collected at nest sites in southern Alberta.

Certainly the most obvious factor in accounting for the differences in prey utilization between urban and prairie-nesting Merlins is the different relative abundances of available prey in the two environments. The prey recorded in this study indicate that Merlins take advantage of species that happen to be abundant in the area at a given time. Certain species, however, such as Clay-colored Sparrows, *Spizella pallida*, and various warblers were not recorded as prey although they are more common than most of the prey species recorded with the exception of House Sparrows. Whether this was due mainly to the low sample size or whether certain birds are less likely to be preyed upon than others is not clear. Hodson (1976) has noted that certain abundant potential prey species are rarely taken. He has suggested that the specific habitat preference (grazed versus undisturbed grassland) and the activity pattern of the feeding birds account for the heavy utilization of certain species rather than others of equal or greater abundance. Birds preferring undisturbed grasslands and having less active feeding patterns were relatively safe from Merlin predation. Similar factors may be involved in affecting prey vulnerability in the urban environment.

Merlins wintering in Saskatoon prey heavily on the few species available. Bohemian Waxwings and House Sparrows are the most common prey species utilized during the winter. This is also true of the

Merlins wintering in Edmonton, Alberta (R. Fyfe in Trimble 1975). The only other species definitely recorded during the winter months was a single Dark-eyed Junco, *Junco hyemalis*.

There is much evidence to suggest that large insects are utilized when abundant, especially by immature birds (see Trimble 1975). Insects may often be the first prey taken by newly fledged Merlins. Hodson (1976) cites an observation of a family of newly fledged young "pursuing and eating grasshoppers during a heavy hatch of these insects." Immature Merlins have been observed capturing dragonflies on the wing in the Saskatoon area in late summer (Oliphant 1974). Young Merlins fledged from an artificial nest structure in Saskatoon during 1975 were observed feeding extensively on dragonflies, which are often abundant in late summer. These birds were also seen pursuing House Sparrows but all the attempts observed were unsuccessful (Oliphant and Thompson, unpublished data).

Observations of a trained, immature female Merlin indicated that dragonflies were much more easily captured than birds although they provided relatively little biomass per kill. Approximately 50% of all attempts at capturing dragonflies were successful during the first two months after fledging; success at capturing birds was less than 5% during the same period. Dragonflies and other large flying insects present in abundance during the first 1-2 months after fledging may be extremely important in sustaining young Merlins as they develop their flying skills.

This study was supported in part by a grant (#A9886) from the National Research Council of Canada. The authors thank W. J. P. Thompson for help in gathering prey remains.

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Use of Man-made Structures as Nest Sites by Pigeon Guillemots

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In western coastal North America, the Pigeon Guillemot (*Cepphus columba*) nests typically in natural crevices in a variety of habitats. Drent et al. (1964) and Campbell (1975) have described six major site-types of enclosed nests on the British Columbia coast. In addition, Dawson and Bowles (1909), Thoresen and Booth (1958), Bowman (1961), and Drent et al. (1964) reported that open ledge sites are occasionally used. Observations during the summers of 1970–1976 revealed the use of man-made structures for nest sites by Pigeon Guillemots. These are listed in Table 1.

Only two of the nine nest sites listed were actually checked. Breeding evidence for the remainder consisted of seeing adults carrying fish, presumably for chicks, or adults flying to nest sites. Nests are suspected, but not confirmed, for sites at Namu and Campbell River.

Eight sites were associated with wharves. The eggs at Sandspit (Queen Charlotte Islands) and Chemainus (Vancouver Island) were deposited on narrow ledges under the wharves. In all cases vertical planks prevented the egg(s) from rolling into the water. Occasionally, adults were observed swimming and/or "bill-dipping" under the wharves and on one occasion

I watched an adult land, with some difficulty, on its nest ledge.

At Horseshoe Bay, near the government ferry terminal, an adult Pigeon Guillemot, carrying a fish, was seen entering a group of wooden pilings. As seen from the ferry, the nest site appeared to be on top of a broken timber in the center of the pilings.

Although most of these man-made structures used by guillemots for nesting have been constructed within the past 30 years or so, it is not known when such use first began.

Available habitat probably does not limit numbers of Pigeon Guillemot in British Columbia as it does for Black Guillemot (*Cepphus grylle*) in northern Alaska (Divoky et al. 1974). The use of man-made structures, however, supports Storer's (1952) view that guillemots are plastic in their choice of nest sites and that cover appears to be a "principal requirement" for nesting.

I thank S. G. Sealy for comments on an earlier draft of this manuscript.

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TABLE 1—Nesting data for Pigeon Guillemots using man-made structures in British Columbia, listed by localities from north to south

Locality	Date	Type of structure	Number of breeding pairs	Breeding evidence
Prince Rupert	5 July 1976	Wharf	3+	Adults flying to nest ledge
Sandspit	16 June 1974	Wharf	1+	One egg; two eggs
Namu	20 June 1976	Wharf	1	Adult swimming under wharf ¹
Port Hardy	1 July 1975	Wharf	1+	Adult flying to nest ledge
Campbell River	10 June 1976	Wharf	3+	Adults on water nearby ¹
Ucluelet	24 July 1970	Wharf	1	Adult carrying fish
Horseshoe Bay	6 July 1974	Piling	1	Adult carrying fish
Chemainus	22 June 1974	Wharf	2+	Two eggs; two eggs
Sydney	25 June 1974	Wharf	1	Adult flying to nest ledge

¹Not positive, but supportive.

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Lysurus gardneri, an Uncommon Stinkhorn Observed in Eastern Ontario

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Stinkhorn is the vernacular name applied to a small group of fungi (Basidiomycetes: Gasteromycetes: Phallales). The name is derived from the general shape, like a cow's horn, and the fetid odor of the mature state. The discovery of an unusual species, *Lysurus gardneri* Berk. (family Clathraceae), was made in 1975 at Navan, Ontario (near Ottawa). The only prior report of this species in Canada is from British Columbia by M. C. Melburn (1966. *Victoria Naturalist* 22(5): 49). Additional records in the National Mycological Herbarium (DAOM) at the Central Experimental Farm in Ottawa are one collection, each, from Ottawa, nearby Russell, Ontario, and Papineau County, Quebec (also near Ottawa). We have learned of a collection on cow dung near Tweed, Hastings County, Ontario, made on 4 October 1976 by F. van Gerwin and deposited in the herbarium of the University of Toronto as TRTC 47654. These Canadian records extend the published North American range of the species, which has been reported from several northeastern states of USA, to as far west as Ohio, and also from California. It is known from several countries of western Europe, South America, and Australasia (from New Zealand to India). Conjectures in the literature are that the species is introduced from the tropics or south temperate regions; it represents the sole representative of the family Clathraceae to be reported in Canada, our other stinkhorns being members of the Phallaceae (with the spore-containing gleba covering an apical portion of the stem or an undivided cap which

hangs down around the stem from its tip).

The habitat of *L. gardneri*, from data with the DAOM collections, was relatively undecomposed horse manure in gardens, greenhouses, and piles of stable-cleanings. The Navan specimens (DAOM 154172) were restricted to a narrow strip of land in a vegetable garden which had been a tethering line for ponies.

The following observations were made from DAOM 154172. The young stage (Figures 1–3) of the stinkhorn is a white soft but leathery globe, commonly called an "egg"; this arises from white mycelial strands. The egg, recognizable when only a few millimetres in diameter, may enlarge to nearly 5 cm. In the early stages (Figure 2), the white fleshy shell (or volva) encloses a layer of gray gelatinous matter (also part of the volva). Inside these layers is a brown tissue from which finger-like projections develop, apparently at the expense of the brown tissue. By the time the volva ruptures, both the gray gelatin and the brown matter are almost gone. Exposed to the air, the remaining gray matter rapidly disappears. Development now proceeds with the elongation of the stem, the growth and separation of the fingers, and the differentiation of a brown sporulating gleba on the wrinkled surface of the fingers (Figures 3 and 4). At full maturity the white hollow stem is 10 to 15 cm long and about 3 cm in diameter, and the pale orange-yellow fingers (five to seven in number) are about 3 cm long and support a brown spore-containing fetid exudate that is conspicuous and attractive to flies.



FIGURES 1-4. *Lysurus gardneri* (DAOM 154172). 1. Four immature stinkhorns in the egg stage. Two have ruptured exposing the apex of the pileus. 2. Vertical sections through five eggs. The youngest egg (top) shows little differentiation, being composed of the brown primordial tissue and the gelatinous outer layer. The other eggs, with the most mature at the bottom, show an increase in egg size as development of the fingers and stalk progresses. 3. Eggs and fully mature stinkhorns. 4. Mature stinkhorn with fetid spore mass almost completely gone from the rugose surface of the fingers. Scale: pen length in Figure 1 is about 14 cm.

Several other observations made on the Navan collection relate to the life cycle and means of dispersal of the stinkhorn. The manure substrate had been fresh in the spring of 1975. A mature stinkhorn was first noted on 12 August, about 3 months later. The fungus probably overwintered in the mycelial state in the garden soil and the fresh manure provided the necessary nutrition to induce fruiting. Alternatively, but seemingly less likely, it is possible that overwintered stinkhorn spores may have been deposited by insect vectors on the relatively fresh manure, the entire development of the fungus, from spore to maturity, taking less than 3 months.

The garden was cleared of vegetables by 17 September and, despite its exposed position, *L. gardneri* flourished. In fact, unlike many large fleshy fungi, the stinkhorn seemed to prosper during hot

sunny weather. Clusters of eggs, which had persisted relatively unchanged throughout the cool moist period of 17 to 26 September, produced mature stinkhorns after only 2 days of warmer dry weather. The maturation of this fragile, quite temporary fruiting state is apparently adapted to the stinkhorn's dependence on insects to disperse the spores; flies were noticeably inactive during the cool moist weather. Besides the numerous green bottle flies (Calliphoridae), two types of beetle were noted, some small rove beetles (Staphylinidae) and a single dung beetle (*Ataenius strigatus*) (Scarabaeidae).

Stinkhorns were still numerous when the final observations were made on 31 September.

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News and Comment

Editor's Report

The numbers of manuscripts received and accepted for publication in *The Canadian Field-Naturalist* in recent years are shown in Table 1. Note that the final disposition of a manuscript may or may not be determined in the same year in which the paper is submitted.

TABLE 1

Year	Number of manuscripts		% accepted
	received	accepted	
1973	153	117	76
1974	152	115	76
1975	167	118	71
1976	147	—	—

Table 2 categorizes, according to fields of study, the manuscripts published in *The Canadian Field-Naturalist* during the past three years.

The papers published in issues Number 1, 2, and 4 of 1976 plus issue Number 4 of 1975 (four issues published per year) have been further categorized in Table 3. If this summary is used as the basis for future comparisons of the proportions of papers submitted or published on the different taxonomic groupings of organisms, new trends or emphasis should become apparent.

TABLE 2

Major subject	Number of manuscripts published in one year		
	1974 ¹	1975 ¹	1976 ²
Birds	56	39	42
Mammals	21	22	33
Plants	16	13	21
Others	14	16	28
Total	107	90	124

¹Includes issues Number 1, 2, and 3 plus issue Number 4 from the previous year's volume.

²Includes issues Number 1, 2, and 4 plus issue Number 4 from the previous year's volume. The special raptor issue, Number 3, which contained 8 articles and 6 notes on birds, is not included.

TABLE 3

Major subject	Number of manuscripts	
	Articles	Notes
Birds	6	36
Mammals	12	21
Plants	6	15
Fishes	2	8
Amphibians & reptiles	1	6
Invertebrates	4	3
Others	3	1
Total	34	90

Request for Participants

International Shorebird Surveys, 1977-78

A cooperative International Shorebird Survey scheme was started in 1975 to obtain information on shorebird migration and to identify and document areas of major importance. This scheme has been highly successful, with much very valuable information on shorebird distribution and migration coming from contributors throughout eastern Canada and the USA, the Caribbean Islands and Central and South America. Information from the scheme will be valuable in assessing requirements for the future protection and conservation of the birds and their habitat. In 1977 we are anxious to continue and extend the scheme in as many areas as possible. Any

observer who may be able to participate in regular survey counts of shorebirds during spring and autumn migration periods, as well as during the winter in shorebird wintering areas, are asked to contact one of the undersigned. Occasional counts from observers visiting shorebird areas on an irregular basis would also be most welcome.

For areas in Canada: Dr. R. I. G. Morrison, Canadian Wildlife Service, 2721 Highway 31, Ottawa, Ontario, Canada K1A 0E7

For areas in the USA, Caribbean Islands, Central and South America: Brian A. Harrington, Manomet Bird Observatory, Manomet, Massachusetts, USA 02345.

Thank You Earl Godfrey

The recent retirement of Dr. W. Earl Godfrey, Associate Editor (Ornithology) of *The Canadian Field-Naturalist* from 1947 to 1976, from the Editorial Board of *The Canadian Field-Naturalist* cannot pass without formal recognition. For his almost thirty years of dedicated service, on my own behalf and that of former Editors of the journal who have had the pleasure of working with Earl, I thank him most sincerely. This acknowledgment is not only for his willingness to serve as a referee for manuscripts in ornithology, the largest single field of journal papers, but also for his devotion to a task requiring someone with his extensive knowledge.

Only some of us realize the amount of time and effort Earl has expended to review and edit manuscripts. In spite of his broad expertise in nomenclature, distribution, plumages, behavior, and ecology of birds, many hours were often taken up in the meticulous study of past records, files, manuscripts, references, and the examination of bird specimens so that he could gain fresh insight into a

subject before he interpreted and evaluated a manuscript.

Earl has always been an active field person, a staunch supporter of *The Canadian Field-Naturalist*, and a strong believer in the journal's worth. He must be commended for the particular attention and encouragement he has given to amateurs. I have been especially appreciative of his concern for, and insistence upon, accuracy, and for his regard for the proper use of the English language. Moreover, although his comments show perception and concern, they are also kind and constructive.

His retirement from the post of Associate Editor of *The Canadian Field-Naturalist* fortunately does not mean that he will no longer be willing to review manuscripts on subjects of special interest to him or that would profit from his particular judgment and experience. Indeed, I intend to call on him from time to time in the future.

LORRAINE C. SMITH,
Editor

Request for Information

Shorebird Color-marking

In 1977, the Canadian Wildlife Service will again be carrying out extensive banding and color-marking of shorebirds in James Bay. Last year, over 12 400 shorebirds were captured during July and August resulting in over 580 reports of color-marked birds in eastern North America and South America. Much valuable information on migration routes is being obtained and observers are again asked to look out for and report any color-dyed or color-banded shorebirds that they may see. Reports should include details of species (with age if possible), place, date, color-

marks and, if possible, notes on the numbers of other shorebirds present. For color-dyed birds, please record the color and area of the bird that was dyed. For color bands and standard metal leg bands, please record which leg the bands were on, whether they were above or below the "knee," the colors involved, and the relative position of the bands if more than one was on a leg (e.g., right leg, blue over metal, etc.). All reports will be acknowledged and should be sent to Dr. R. I. G. Morrison, Canadian Wildlife Service, 2721 Highway 31, Ottawa, Ontario, Canada K1A 0E7.

Request for Information

Color-banded Semipalmated and Least Sandpipers

Last year the Surinam Forest Service color-banded nearly 3300 Semipalmated and Least Sandpipers, resulting in 14 spring and summer sightings and recoveries from the United States and Canada. In 1977 again large numbers of these species will be color-banded along the Surinam coast. As in 1976, birds will be banded above the tarsus ("knee") with a standard aluminum band and TWO ORANGE plastic bands of about the same size as the aluminum

band. We again ask birders to look out for these birds and to send reports of observations to Arie L. Spaans, Surinam Forest Service, P.O. Box 436, Paramaribo, Surinam, South America. Please report species, date and location of observation, the position of the aluminum and color-bands—left or right leg, and, if more than one band is on a leg, which band is above, which below, and which in the middle (some birds have all three bands on one leg)—and the number of color-banded birds involved.

Pilot Study for a Biological Survey of the Insects of Canada

Have you received a questionnaire?

The Entomological Society of Canada has been awarded a contract by the Canadian Government to conduct a Pilot Study for a Biological Survey of the Insects of Canada. This project is intended to establish the foundations for a continuing biological survey, and a major aim is to assess the resources and needs of Canadian research in the identification, distribution and biology of insects (including arachnids and other related forms).

Four types of questionnaire have therefore been distributed. If any readers have information to contribute on relevant resources or needs and were overlooked in the original mailing, we would be very pleased to receive requests for the applicable questionnaires as listed below.

(1) Questionnaire to individual entomologists, to

ascertain the location of personnel and programs, and seek information on the state of knowledge in Canada of their taxonomic or ecological groups of interest.

- (2) To resource managers, environmentalists and other users of information on insects, to ascertain their present and future needs for entomological information.
- (3) To directors of institutions conducting entomological research in Canada, to ascertain programs and facilities.
- (4) To curators of collections in Canada and elsewhere, to ascertain the whereabouts of significant holdings of Canadian arthropod material.

Secretariat, Biological Survey Project, 202-1316
Carling Avenue, Ottawa, Ontario K1Z 7L1

Colonial Waterbird Group First Annual Meeting

The Colonial Waterbird Group, organized during the Wading Bird Conference at Charleston, South Carolina last October 1976, will hold its first annual meeting on 21-23 October 1977, at Northern Illinois University, in DeKalb. The conference will include paper sessions, subgroup meetings (surveys, conservation, etc.) and an important business session. Any person wishing to present a paper on an aspect of research or management of pelicans, cormorants,

herons, ibises, gulls, terns, alcids or other colonial waterbirds should submit a single page abstract no later than 15 August 1977 to the National Audubon Research Department, 115 Indian Mound Trail, Tavernier, Florida 33070. Additional information on the conference will appear in the mid-summer CWG newsletter, or may be obtained by writing the above address.

Book Reviews

ZOOLOGY

Biology of the Kaminuriak Population of Barren-ground Caribou. Part 2

By Frank L. Miller. 1974. Canadian Wildlife Service. Ottawa, Report Series Number 31. 88 pp. \$3.00.

The Canadian Wildlife Service in 1966 began a 2½-year intensive study of the Kaminuriak population of barren-ground caribou. The study was divided into four parts, each the responsibility of the CWS biologist: total numbers, distribution, recruitment and mortality; sex and age composition; seasonal physical and reproductive condition; and winter range evaluation. Although the study was undertaken primarily by the Canadian Wildlife Service, the game agencies of Manitoba, Saskatchewan, Alberta, and the Northwest Territories all contributed personnel at various stages of the project. The results of the research project were reported to the Administrative and Technical Committees for Caribou Preservation in 1970. This publication constitutes a report of the second part of the study. (Part 1 by G. R. Parker, which included total numbers, mortality, recruitment, and seasonal distribution was published as CWS Report Series Number 20, in 1972. Reviewed in *The Canadian Field-Naturalist* 88(3): 376-377.)

The current report is divided into two parts: (1) dentition as an indicator of age and sex, (2) socialization and population analysis. A sample of 999 caribou, including all important age and sexual classes, was collected systematically at four seasonal periods from March 1966 to July 1968. Nine hundred and forty-three caribou were collected from the Kaminuriak population and 58 from the adjacent Beverly population. This sample represented approximately 1.5% of the total population (63,000, Parker 1972). This number may have provided a statistically valid population sample, but it is large enough to raise concerns among conservationists as well. It is to be hoped that other caribou populations need not be subjected to such intensive sampling.

Age was estimated by tooth eruption and replacement, by linear tooth measurement, and by microscopic histological examination of the cementum layer of mandibular teeth. The author presented a convincing case for the annual deposition of an annulus (winter rest line). He reported the eruption of the permanent dentition between the ages of 24 and 29 months. The difference between Miller's conclusion and my earlier work (Preliminary investigation of the barren-ground caribou. Part 2. C.W.S. Wildlife Management Bulletin Number 10b, 1954) is the result

of my reliance upon a small control sample of 12 mandibles from tagged reindeer of known age from the Mackenzie Delta herd. Considerable variation in tooth eruption at standard ages was noted as well as the need for more data on differential wear of forest and tundra caribou relative to differing feeding behavior. If one also added genetic differences between reindeer and caribou populations, it might be possible to account for the differences in conclusions. The subsequent discussion of cohort mortality could have been clarified if the author had distinguished density-dependant and density-independent mortality factors.

The second part on socialization commences with a definition of the various types of age and sexual groupings which the author defines as *bands*. The statistical analysis of the occurrence of radio-tagged caribou indicated the social cohesion of these bands. Miller postulated that the winter groupings are basic, and the post-calving aggregation serves to reunite the previously segregated winter bands. He further postulated that the herding behavior of caribou evolved as a defense against wolf predation, because the herds saturate the wolves' hunting territories. He might have considered the migratory behavior of wolves in packs over much of the year, which would counteract that defense mechanism to a considerable degree. In my view, the long caribou migration from the winter ranges in spring is an effective way of leaving behind the wolves which commence to den in April-May. Fawning then takes place in areas where the resident wolves are restricted to their denning territories.

The final section on population analysis of the Kaminuriak population was based upon the age and sex composition of the sample population. It clearly indicated a weak 1962 cohort such as is frequently found in fish population studies. Survival curves were prepared by adjusting the numbers for this weak class, and significantly different male and female survival rates were indicated. In his conclusion the author recognized the difficulties in overcoming sampling bias on various age and sex classes.

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Biology of the Kaminuriak Population of Barren-ground Caribou. Part 3

By Donald R. Miller. 1976. Canadian Wildlife Service, Ottawa, Report Series Number 36. 42 pp. \$1.75.

This publication which is subtitled "Taiga winter range relationships and diet," is a report on the last part of the intensive study of the Kaminuriak population. T. C. Dauphine, Jr. will soon publish as Part 4, the report on growth, reproduction, and nutritional condition (see New Titles list in *The Canadian Field-Naturalist* 91(1)).

The author studied the winter range and diet of the Kaminuriak population in northwestern Manitoba and northeastern Saskatchewan by means of vegetation quadrats, exclosures, and the study of feeding activity, feeding craters, and rumen contents. The potential forage was determined by quantitative data on standing crop and percentage plant cover. Terrestrial lichens covered 50 to 90 percent of the ground in exclosure plots and the standing crop of terrestrial lichens varied from 2000 to 7000 kg dry weight per hectare. Lichen regeneration of primary thalli on artificially denuded plots occurred on all plots after three growing seasons. The author found no relationship in the terrestrial lichen standing crop with age of the stand over 30 years, although the data in Figure 4 appear to suggest increasing biomass in similar stands up to 120 years of age.

Climatic factors, especially snow depth and crust

hardness, were reported to account for the sudden changes observed in caribou diet. The diet of early winter was predominantly terrestrial lichens. This changed to arboreal lichens and woody browse in late winter. As the snow melted in spring the caribou fed heavily on exposed lichens and higher plants along migration routes. Forest fires were considered beneficial because they provided heterogeneity of plant cover in the taiga. Based upon quantitative caribou food studies elsewhere, the winter range of the Kaminuriak population was estimated to have the carrying capacity for 360 000 caribou (about 6 times the current population).

Unfortunately, there were several errors in the report, including Figure 4, and a sheet of "Errata" has been issued. Readers should ensure that the page is included in their copy of the report. With the publication of these reports, the Kaminuriak population has become the most intensively studied of all the caribou "herds," and our understanding of its population dynamics has been placed on a level equivalent to that of other well studied species such as the African elephant.

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The Insects and Arachnids of Canada. Part 2: The Bark Beetles of Canada and Alaska

By Donald E. Bright, Jr. 1976. Agriculture Canada, Ottawa. 241 pp., illus. \$7.00 in Canada, \$8.40 other countries.

This book is part of a Canadian Faunal Series being developed by staff of the Biosystematics Research Institute, Canada Agriculture, as identification guides to the arthropods of Canada. These guides are designed to permit the identification of organisms by the general biologist, senior technician, or advanced amateur.

Although *Bark Beetles of Canada and Alaska* is Part 2 of the series, it is the first to be published. Part 1, a handbook of entomological techniques, has been delayed by the preparation of illustrations. Other contributions in the series have been submitted for publication or are in late stages of preparation.

This is the first comprehensive treatment of species of bark beetles in Canada since J. M. Swaine's *Canadian Bark Beetles*, published in 1918. Swaine's book provided excellent coverage of the bark beetles

but has long been out of print and unavailable to most people. Consequently this handbook will once again provide students, amateur collectors, foresters, and others with a means of identifying various species of Scolytidae.

The reader is given a brief account of the general biology of bark beetles which is followed by a discussion of the types of galleries created by the adult and larval forms. These types are illustrated by a number of photographs of typical bark beetle patterns. I would have preferred seeing these illustrations adjacent to the pertinent section in the text rather than at the back.

Adult anatomy is described and illustrated in only sufficient detail to include the parts of the body used in the descriptions and in the keys. Descriptive terminology is further defined in a glossary at the back of the book. The user is not burdened with more descriptive morphology than is required to use the book for its intended purpose, i.e., identification.

Two hundred and fourteen species in 45 genera known or suspected to occur in Canada and Alaska are dealt with. For each species the following information is given: synonymy (if any); a brief diagnosis emphasizing the most obvious or easily visible morphological features; host plants; geographical distribution supported by a map of localities where the species has been found; and a brief summary of the biology if known. A particularly valuable feature is the reference to more detailed accounts of biology of the species where known so anyone can proceed beyond mere identification if he so desires.

The book is well organized and easy to use. Those not familiar with scolytid taxonomy should have no difficulty in keying to genera and then to species. Important diagnostic features of parts and entire species are illustrated by 173 photographs taken with

the aid of a scanning electron microscope. For instance, dorsal and lateral views of a representative species of 38 of the 45 genera are included, as well as superb illustrations of antennae and tibiae. These figures are referred to in the pertinent sections of the keys with only one omission that I noted. Reference to Figures 133 and 171, *Xyleborus*, is omitted from couplet 34 of the generic key.

This handbook provides a much needed reference guide to the Canadian bark beetles and I would recommend it for inclusion in university libraries, and as a personal choice for anyone interested in knowing a little more about this group of beetles.

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A Book of Canadian Animals

By Charles Paul May. Illustrations by John Crosby. 1976. Macmillan of Canada, Toronto. 115 pp. Paper \$4.95.

This book was written for, and should appeal to, children aged from about eight to twelve years. It contains twenty-eight short chapters, each describing a different mammal and some of its habits. For each chapter, a line drawing of the adult and young for the species concerned accompanies the text.

The chapters all follow roughly the same format. The animal is introduced and the reader is told where in Canada it is usually found. Next we are told what it eats, where it lives (i.e., in a burrow or whatever), and any unusual habits are mentioned. A major focus for each chapter seems to be when and how many "babies" are born to mother and father animal, and for some, whether they make good pets. Most chapters finish with a brief passage relating the animal's usefulness or special interest to man.

I gave the book to a grade five teacher who circulated it amongst her pupils. Their responses to it were varied but all seemed to enjoy and like the book. Two consistent comments were that the chapters were much too short and gave the children a sense of incompleteness; and the children liked the drawings but wished they were in color and much larger. Generally, the children found the book enjoyable and readable, but would not exactly call it entertainment. Perhaps this was because they read it in school, but on a volunteer basis.

In my opinion, a book of animals would contain not just mammals, as this one, but also birds and reptiles, or perhaps even insects and fish. But I do not believe

the title is misleading to youngsters. The coverage of species is wide and interesting, with the omission of caribou, black bear, mountain sheep, and elk. Other species found here, including the pocket gopher, the star-nosed mole, and the pika, are not usually represented in animal surveys for children.

The preoccupation in the book with "babies" of the animals discussed is presumably a technique for capturing and maintaining the interest of youngsters. The unfortunate cumulative impression is that the animals are "cutesy-pie" and "cuddly"; that they make good or bad pets, or that they are scary and dangerous when hungry (see the pages on the gray wolf, p. 109). This is the information that persists in the mind long after the more important details of life history have vanished. Is this the intent of the book? The problem of human values and attitudes pervades much of the wildlife literature and film meant for children and calls into question precisely what is the role of such media in pre-adult nature education.

I suggest that the potential impact of this book goes beyond providing information in a simple manner. It extends into the realm of reinforcing a paternalistic and anthropocentric attitude toward nature. The technique is subliminal and the impact is cumulative. I would suggest that the use of this book by youngsters should be accompanied by careful guidance from parents and teachers.

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An Investigation of Caribou Range on Southampton Island, N.W.T.

By G. W. Parker. 1975. Canadian Wildlife Service, Ottawa, Report Series Number 33. 83 pp. \$2.75.

Excessive hunting on Southampton Island in northern Hudson Bay led to the extermination of the native caribou by 1955. Caribou were captured on nearby Coats Island in 1967 and airlifted to Southampton Island where 48 were released. The author studied the island vegetation in 1970 to 1972, as to forage quality and quantity in order to evaluate the carrying capacity of the range to support barren-ground caribou. By means of aerial photographs he divided the island into land-form types on the basis of moisture regimes and physiographic features. Parker follows F. A. Clement's classical definition of plant formation as the climatic climax vegetation. Plant associations were considered the lowest unit for detailed description. The various plant associations were studied by the line-transect and plot method. In this case the line transects were 70 m long with fifteen 1-m² plots selected at 5-m intervals. Data were collected on species frequency, cover and weight of the aboveground parts of the plants. Samples of lichens were analyzed for total nitrogen, caloric energy, and for phosphorus, calcium, magnesium, potassium, and

sodium in the laboratory.

It was found that most herbaceous forage was produced in the limestone Hudson Bay lowlands while the most productive region for lichens was the Precambrian Plateau along the northeast coast. The greatest standing crop of lichens was approximately 1000 kg dry weight per hectare but the nutritional value of the lichens was low. It was concluded, however, that the quality of forage on the island was not a problem and an optimum caribou population for the island would be about 40 000 animals.

The population was forecast to reach 1000 animals by 1980; afterwards, with the cooperation of the local Inuit, a modest harvest could be sustained.

The Coats Island caribou were found to be exceedingly fat and the heaviest specimens for barren-ground caribou in Canada were recorded. Several males exceeded 180 kg in weight. The Coats Island population in March 1970 was approaching 2000 animals.

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Mammalogy

By Harvey L. Gunderson. 1976. McGraw-Hill, New York. 483 pp., illus. \$19.80.

Harvey Gunderson of the University of Nebraska should be commended on writing a stimulating text on mammals. Unlike several recent books on mammalogy, such as Cockrum's *Introduction to Mammalogy* and Vaughan's *Mammalogy*, it makes no attempt to include extensive descriptions of the many living kinds of mammals; such information is valuable, but it can be obtained in other sources, such as Walker's *Mammals of the World*. Rather Gunderson concentrates on bringing together an interesting assortment of information from varied primary sources.

The most innovative of Gunderson's 16 chapters is that on the history of mammalogy as a science, beginning with its roots in European natural history and continuing with discussions on natural history in early America, the discoveries of explorers and fur traders, and finally the emergence of mammalogy as a discrete discipline. There is a useful section on collections of mammal specimens in United States museums and universities, on mammalogical work

done by American federal and state government agencies, and on journals devoted to research on mammals.

Other sections of particular interest in this book are those on taxonomy and on physiology and behavior. Gunderson has used recent references on which to base his comments, so that his discussions are up to date, and often accompanied by well chosen figures and good photographs.

It is understandable that in a large work of this scope some inconsistencies, repetitions, and errors will slip in; the use of both *Lontra* and *Lutra* for the otter; the statement that the camel's temperature varies between 34° and 41°C repeated three times (temperatures are given in degrees Celsius, lengths and weights in both metric and non-metric units); and the use of the generic name *Zebra*. One must also contest Gunderson's statement about Sir John Franklin's last expedition in search of the northwest passage, "the earlier disappearance of whose members remains a complete mystery to this day" (p. 16). In fact Captain M'Clintock in his book *The Voyage of the 'Fox' in the Arctic Seas* (1859) described how the fate

of Franklin was discovered. (This book was reprinted in 1972 by Hurtig Publishers of Edmonton.)

One small detail that bothered me was the use of a mammal's scientific name on every possible occasion, especially such contentious ones as for the moose (*Alces americana*) and for the wolverine (*Gulo luscus*). The word pronghorn is followed by *Antilocapra americana* over 20 times in the text. Surely in the interests of saving space, a list equating the

common and scientific names of a species could have been appended at the end of the book.

Overall, this work is a fine one, up-dating previous texts on mammalogy. I am sure it will prove useful to future classes studying this subject.

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BOTANY

Common Weeds of Canada/Les Mauvaises Herbes communes du Canada

By Gerald A. Mulligan. 1976. McClelland and Stewart. Toronto (in association with *Information Canada* and The Department of Agriculture). 140 pp. Paper \$4.95.

The need has long been felt for a reasonably priced set of colored pictures of weeds. This completely bilingual book is definitely a step in the right direction. It contains 117 colored plates depicting 117 weeds of regional or widespread occurrence across Canada. Ten illustrations were reproduced from water-color drawings by the late Norman Criddle, first published in 1906 in *Farm Weeds of Canada*, now long out of print. The rest are from the author's own colored photographs. Nearly all of the illustrations are about $3\frac{1}{2} \times 5$ inches (9×12 cm) and occupy the lower half of one page with the names and text above. Full-page illustrations are used for poison-ivy and common ragweed, the two weeds that figure most importantly as causes of human misery and discomfort in Canada. Most of the photographs are of a general view of one plant or a group of plants in natural setting. This has virtue in helping the reader form the valuable mental association of where a plant grows, together with what it looks like. But this also has the disadvantage of the plant being submerged into the background where the two are not in sharp contrast, either by color or by focus, with the result that some diagnostic features necessary for identification cannot be distinguished. Unfortunately, this happened in a number of the photographs, and their usefulness is less than might have been.

Accompanying each illustration are the common and botanical names of the weed, the name of the family to which it belongs, and a paragraph including its life duration (annual, perennial), how it spreads, how high its stem usually grows, whether it is native in Canada or introduced, the provinces where it occurs, the habitats in which it is usually found, and the time

of year when it flowers. The reader who seeks a more complete description of each weed is, in the Introduction, referred to the revised edition of *Weeds of Canada*. (This is an excellent book, published by Information Canada in 1970 with Mr. Mulligan as senior author, containing detailed descriptions with very accurate black-and-white line drawings.) Nevertheless, had even a few of the more significant distinguishing characteristics of each weed been included in this new book, its value would have been much enhanced. This is especially true for those weeds whose features are not readily visible in the photographs.

Good quality paper was used and a nearly natural balance of color was achieved in most plates. In a few, however, such as sulphur cinquefoil, the yellow was printed too lightly so that the petals turned out nearly white, and in others, especially the Mint and Composite families, the pinks and mauves lack the brilliance normally associated with their flowers. Only one typographical error was noted: the second *t* was missing from *Bromus tectorum* in the French column although it was spelled correctly in the adjacent English column.

Attractively bound in a varnished black paper cover with an eye-catching group of 5 colored pictures on the front, this book will appeal to those who want a decorative volume as well as those who want help with identification of weeds. Being of pocketbook size, $5\frac{1}{4} \times 8$ inches (13×20 cm), it can be easily carried in the field, and, being completely bilingual, it should find ready acceptance in every province of Canada.

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Index to Plant Distribution Maps in North American Periodicals through 1972

Compiled by W. Louis Phillips and Ronald L. Stuckey.
1976. G. K. Hall and Co., Boston. xxxvii + 686 pp.
U.S. \$121.

Plant distribution maps are invaluable resources for biogeographers and biosystematists, providing insights into evolutionary histories and barriers to interbreeding. For naturalists and conservationists, they indicate which species can be expected to occur within areas of interest and which may be locally noteworthy or rare. Taxonomists and naturalists generally will welcome the publication of this index. It will be useful not only for the specific purpose of locating maps but also as a guide to literature on the respective taxa. There have been numerous occasions in my own research and in dealing with requests for information when such an index would have been most helpful.

The 268 journal titles listed (some merely name changes) represent a prodigious effort in searching as many North American periodicals carrying botanical articles as possible, including not only the well-known taxonomic journals but also many state academy journals, amateur naturalists' magazines, and short-lived private publications. Thirty Canadian titles are

listed. Because only journals published in Canada and the United States are covered, some maps of plant distribution in other parts of the world are indexed, and maps of North American taxa published elsewhere are not. A list of books containing plant distribution maps appears as a supplement.

The 28 772 entries appear alphabetically by scientific names, adhering to those used by the authors of the cited papers. Each entry includes the journal title, volume, page number, and year of publication, the type of map (e.g., dot or shaded), the geographic area covered, and the author's name. Maps of both vascular and lower plants are indexed.

This index is printed on good-quality paper, and is sturdily bound. Among books reproduced by offset from typed cards, it is extraordinarily neat and attractive. Its price will deter most individuals from purchasing this index, but it should be acquired by libraries wherever research in plant systematics and biogeography is conducted.

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A Dictionary of Useful and Everyday Plants and Their Common Names

By F. N. Howes. 1974. Cambridge University Press, New York. 289 pp. \$12.95.

Anyone who has ever used *A Dictionary of the Flowering Plants and Ferns* by J. C. Willis, 6th edition, 1931, will want to have a copy of this new book by F. N. Howes. When the already voluminous 1931 *Dictionary* was revised in 1966 so much new technical information on generic and family names had to be included that information on common names of plants and plant products had to be omitted. This omission was sorely felt by scientists and by users alike. F. N. Howes, then Keeper of the Museum of the Royal Botanical Gardens in Kew, England, undertook to fill that gap. He updated the material left out of recent editions by Willis and added so much new information that this volume now contains more than twice as many entries as before.

Each entry is the English name of a plant, part of a plant, a plant product, or the name of some person or condition associated with plants, or rarely, the botanical name of a plant. Entries are arranged in alphabetical order and have been accumulated from all over the world where English is or has been used or spoken. Each is accompanied by a brief but usually adequate description or definition plus the genus and

species or just the genus of the plants involved. Where the same name refers to different products or species in different parts of the world, the country or region is indicated for each (e.g., Aust. for Australia, SE U.S. for southeastern United States of America, N. Am. for North America). There is a reasonable amount of cross-referencing as well. In many instances one common name merely refers to a second common name at which is found the definition and botanical name. Compound names, consisting of two or more words, are usually entered alphabetically by the first word only, e.g., "Thyme, common or garden *Thymus vulgare*" is defined under the "T's" but "water thyme" (*Anacharis*, *Elodea*) is found only under "W"; "Ash pumpkin" appears only under "A," not under "P." Fortunately, however, many entries are included under both letters, although sometimes incompletely so, such as "Prickly ash" which, under "A" refers to "*Zanthoxylum* spp.; *Aralia spinosa*:" but under "P" refers only to "*Zanthoxylum* spp."

Coverage tends to be better for plants of the United Kingdom, Africa, Australia, and the USA than of Canada or the Indian subcontinent. Although many Canadian native plants, cultivated introductions and introduced weeds are included, this seems to be largely

as a consequence of their occurrence in other parts of the world. For plants whose Canadian common name is the same as in the Old World there is no problem; but where different common names are used in the two regions for the same plant, it is frequently entered only under the Old World name. Or, where a particular common name applies to different plants in the two regions, the Old World definition is always given, but frequently there is no mention of the Canadian or North American usage.

No large compilation like this can be entirely free of errors. Obvious typographical errors are virtually non-existent. Spelling errors are few and far between — an amazing feat when one considers the variety of

sources from which this material was assembled: for example, *Acacia cyanophylla* was named after the Australian town, Cootamundra, but the spelling given here is Cootaminda; and the well-known Gray's Manual of Botany, eighth edition, was authored in 1950 by M. L. Fernald, not by A. Gray.

Nevertheless, this *Dictionary* is a most valuable compendium of information about "Useful and Everyday Plants" to Canadian users as well as to others throughout the world.

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A Panorama of Canadian Forests

By Albert Potvin. 1975. Canadian Forestry Service, Department of Forestry, Ottawa, Canada. 254 pp., illustrated in color. Available from Information Canada, Ottawa. Canada \$13.50, other countries \$16.20.

In this volume Albert Potvin has woven a brief outline of the forests of Canada about an absolutely striking series of color photographs, taken mostly by himself, from Newfoundland to British Columbia. The development of our forests is traced after glaciation to the eight forest regions recognized in Canada today. These regions are illustrated, both in close-up and from a distance. The role of fire and the elements and indeed the pressures of man are presented, together with a discussion of forest communities, tree distribution, and the inhabitants of the forest. The final chapter is a discussion of the future of

our forests, one of our most important possessions and a legacy to future generations.

As a livingroom volume, *A Panorama of Canadian Forests* will receive much interest as viewers enthuse over the delightful pictures. It will, however, also be a pleasure for quiet contemplation. The young student may too have his appetite whetted to develop his interest in our forested lands. To the stranger to Canada, it may foster a desire to visit this country to see it first hand. Ce livre est disponible aussi en français sous le titre *Panorama des forêts du Canada*.

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Canadian Wildflowers

By Mary Ferguson and Richard M. Saunders. 1976. Van Nostrand Reinhold, Toronto. 169 pp. \$19.95.

This is a delightful collection of beautiful color photographs of flowers that may be found in various parts of Canada, east, west, north, and south and from fields, forests, mountains, and arctic tundra. Many have previously been published in desk-calendar form as *Canadian Wildflowers 1975*, *Canadian Wildflowers 1976*, and *Canadian Wildflowers 1977* by Van Nostrand Reinhold, all authored by Mary Ferguson. The photographs were taken mostly by Mary Ferguson, but 15 other photographers have made contributions. Most of the pictures show only the flowers (or in some cases fruits) and not the whole plant, thus allowing for great depth of focus within the limited field. The colors are remarkably true. The

'Canadian' may be a slight misnomer, however, because there is a sprinkling of photogenic introduced species such as Purple Loosestripe, Bull Thistle, and Teasel.

Each of the 144 species pictured is accompanied by an interestingly written description of the plant, its habitat and distribution, and items of particular interest concerning it.

This is a "coffee table" book, which will certainly instil an interest in the delight of closely observing the flowers around us, in all those who turn its pages.

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Rocky Mountain Flora

By William A. Weber. 1976. Colorado Associated University Press, Boulder, Colorado. 479 pp. \$12.50.

This is an excursion flora which any interested naturalist would find invaluable on a trip through Colorado, southern Wyoming, and northern New Mexico. Its popularity is evidenced by the fact that it is now in its fifth edition since first being published in 1953 as "Handbook of Plants of the Colorado Front Range." The third and fourth editions were reviewed in this journal in 1968, Volume 82: 61; and 1973, Volume 87: 194.

There are many changes in this edition: families are introduced with a paragraph of interesting and very readable information; many of the keys have been rewritten and species recently found in the region have been added so that about 1600 species, over half the

flora of Colorado, are treated; observations on the ecology of some species have been adjusted as a result of field experience; new line drawings have been added; and the nomenclature has been updated.

In this new edition the author laments the changes which have taken place throughout the region through the ravages and other results of urbanization. He has, however, provided a volume which has kindled an interest in the flora and through it may stay at least a part of the desecration of the country which has taken place since he began his studies of the flora of the Front Range.

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Guide to the Vascular Flora of Illinois

By Robert H. Mohlenbrock. 1975. Southern Illinois University Press, Carbondale and Edwardsville. 494 pp. \$7.95 (paperbound), 12.95 (clothbound).

In 1967 Robert Mohlenbrock published the first volume of *Illustrated Flora of Illinois: Ferns*. This was followed by *Flowering Rush to Rushes* in 1970; *Lilies to Orchids* in 1970; *Grasses: Bromus to Paspalum* in 1972; and *Grasses: Panicum to Danthonia* in 1973; and *Sedges: Cyperus to Scleria* in 1976. It is obvious, however, that this series will take many years to complete at the present rate of publication.

In the *Guide to the Vascular Flora of Illinois*, Mr. Mohlenbrock has taken the keys from the published volumes of the illustrated flora and those as yet unpublished, and consolidated them. To these he has added a key to families, brief descriptions of 14 physiographic regions under the headings of glacial history, bedrock, topography, soils, plant communi-

ties, aquatic habitats, and distinctive fauna, indexes to common and scientific names, a glossary. Common names are given when known, occasionally very brief descriptions; notes on habitat, and when rare, localities are given for individual species.

The result is a handy little book which can readily be carried in the field. It will be most useful to students and naturalists who are interested in studying the flora of Illinois and adjacent regions. In Canada the book could be used to key out plant species in the southern parts of Ontario, for which unfortunately there is as yet no flora published, but the users in this province will of course find many species in it which do not occur in Ontario.

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ENVIRONMENT

Superior: The Haunted Shore

By Bruce Littlejohn and Wayland Drew. 1975. Gage Publishing Ltd., Toronto. 176 pp. \$35.00

According to the authors, *Superior: the Haunted Shore* has two themes: "The first is the co-existence of power and fragility . . .," "The second is the humbling

insignificance of the human record as the rocks of Lake Superior reveal it . . ." It is the unique treatment of these two themes, however, which is the essence of this book.

Each of the authors accepted one theme. "United in essentials, we therefore chose to work individually

during the writing and final selection of photographs, rather than striving for an integration which could easily become contrived and artificial." The "power and fragility" theme is revealed through the excellent photographic efforts of Bruce Littlejohn. The book's second theme, "the human record" is reported in the written words of Wayland Drew.

The 98 color photographs selected by Bruce Littlejohn for inclusion are all of excellent photographic quality. All portray the natural features of the Superior shore. All are of a high artistic merit. None portray people or the human impact and/or existence on the Superior shore.

If one is to find fault with the photography it would not be with the photographic skill of Littlejohn. One might suggest that there are too many similar-type shots included in the collection, such as waves crashing onto rocks. Shots I feel are missing are those from the numerous high lookouts along the north shore which show the vast magnitude of the lake and

the cold white-blue color of the water.

Wayland Drew's text is primarily historic, recounting legends and events, and describing people of times long past. Every so often reference is made to a Lake Superior site in a more current context, but this is a minor portion of the text. Whereas the Littlejohn photographs completely exclude people, the text of Drew is all of people. The writing is easy and enjoyable reading with the only noticeable flaw being the unfinished sentence on page 54.

If this book has a fault it would be that only the north Canadian shore is treated. No consideration is given to the American Superior shore. Granted, the book's present content makes it purely Canadian; however, to those who enjoy the world's natural resources, nature's treasures do not adhere to political boundaries.

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The Economy of Nature

By Robert E. Ricklefs. 1976. Chiron Press, Portland, Oregon. 455 pp., illus. \$13.95.

It was a pleasure to examine Robert Ricklefs' textbook in basic ecology. The book has been divided into nineteen chapters. The core idea of form, function, and factors is well established. The interdependence of the physical and biological realm was firmly believed to be the basis of the ecosystem concept. Examples were cited profusely throughout to present action, coaction, and interaction between organisms and against physical environment. The cycles of water, oxygen, carbon, nitrogen, and phosphorus were exhaustively dealt with. The book covers many minute details of every ecological phenomenon inevitably needed by a beginner. To my surprise, the topics like photoperiodism and circadian rhythms were omitted. This is not a drawback but they would have added interesting information to the total. Raunkiaer's Life forms begin on page 73, but the

index shows page 75; this is a minor error. A table of conversion factors for area, length, time, mass, volume, velocity, energy, and power is included. A glossary giving all the definitions and meanings of ecological terms is added. At the end is a list of selected readings and text references for each of the chapters dealt with. These are quite useful. At the same time, had there been a listing of all references (of Oosting, Phillips, Brown) about field techniques, it would have been very beneficial to the budding ecologist. On viewing all the above facts, I consider the book is quite readable, well composed, and balanced in subject matter, and is worth reading by anyone who is interested in ecology particularly, rather than by a student taking a course in a university.

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Nature and Urban Man

Edited by Gerald B. McKeating. 1975. Canadian Nature Federation, Special Publication Number 4. Ottawa, Canada. 184 pp. \$4.

This is a symposium volume comprised of nineteen papers. The stress is on the complex relationship

between man and the natural world. The purpose is to show some of the work undertaken and to identify some possible solutions. The contents are divided into five sections: overpopulation, capability of nature to survive in urban areas, the work undertaken by naturalists today, need for education and new approaches to planning and programs, and the

approach by municipal and provincial authorities in Ontario. Specific examples were taken and discussed. Any conservation program should accommodate legitimately proper water management, recreational facilities, and wildlife management. A good suggestion was made, that is, the appointment of ecologists as staff members in professional schools of Law, Medicine, Architecture, Planning, and Engineering to broaden the professional orientation in environmental issues and/or field ecology at second, third, and graduate level. A registry of professional ecologists is maintained in New Zealand and an appeal is made to Canadian authorities to follow it up for keeping a standard of environmental quality. The role of each professional in planning, policy-making, and program-developing is discussed, for example,

the role of an engineer, ecologist, public representative, biologist, etc. On the whole, the series of papers gives an insight into the various problems that exist in Ontario. Though all appear in tidbits, a theme is maintained consistently so that one can grasp the hazards of urbanization. The pros and cons of every little ecological problem under study were dealt with. I hope that the Canadian Nature Federation will continue its efforts with the same vigor in near future to bring out the degree and frequency of abuse during the battle between man and nature.

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OTHER

Marine Sediment Transport and Environmental Management

Edited by Daniel Jean Stanley and Donald J. P. Swift.
1976. Wiley, New York. xv + 602 pp. \$35.

This book by some twenty-three leading contributors is an outgrowth of lectures presented as a short course, 'The New Concepts of Continental Margin Sedimentation, II,' sponsored by the American Geological Institute. Its target audience is ocean scientists, ocean engineers, and the environmental managers representing the public who "must reconcile the competing demands made upon the (continental) shelf." I remark that this latter description seems more appropriate to maximal utilization than to management in the broad sense.

This book reflects a trend in the field toward a more holistic, dynamic approach. It is more holistic in that physical oceanography, chemical, and biological concerns are treated together with the sedimentology with some interpenetration of ideas. Dynamical oceanography occupies five early chapters. Sediment transport, both in bed load and in suspension, is discussed in equal detail. Patterns of sedimentation on beaches, at coastal inlets, on rocky coasts, at the continental shelf break (outer margin), in submarine canyons are similarly presented.

The suite of six chapters on 'Sedimentation and Environmental Management' discusses sedimentation with respect to beach and harbor engineering, structures, ocean mining, and ocean dumping. If one

accepts the premise that it is man's activities rather than the environment that is to be managed, then the words, 'environmental management' in this suite of chapters and in the book's title would be better replaced by 'environmental utilization.'

This volume is many textbooks in one. The marine practitioner can quickly choose for himself a set of chapters which will provide him a course of background reading addressing his current need.

Some observations, offered in the Epilogue, help to place this work and this field of endeavor in perspective. Continental shelf sedimentology has been motivated largely by searches for petroleum and minerals. Studies of shore processes have been motivated by the requirements of coastal engineering. The field bespeaks bigness — in geographical extent, in expense, in the scale of man's interventions, and in the epilogue writer's projections for its future. There are, however, signs in this text and in the field that the natural limits are beginning to be perceived. Studies of the effects of dumped spoils on shelf waters and sediments are being actively pursued. The role of sediments in supplying nutrients for shelf fisheries is beginning to be appreciated.

RONALD H. LOUCKS

R. H. Loucks Oceanology Ltd., 24 Clayton Park Drive,
Halifax, Nova Scotia B3M 1L3

NEW TITLES

Zoology

- Amphibians and reptiles in Alaska, the Yukon and Northwest Territories.** 1976. By Robert Parker Hodge. Alaska Northwest (Canadian distributor, Hurtig, Edmonton). 92 pp., illus. Paper \$4.75.
- † **Annotated checklist of the birds of Ontario.** 1976. By R. D. James, P. L. McLaren, and J. C. Barlow. Royal Ontario Museum, Toronto. 75 pp. \$2.50.
- † **Biocides and birds.** A survey of the effects of biocides on birds. 1976. By R. E. Rogers. Alberta Environmental Conservation Authority, Edmonton. vii + 90 pp. Paper free.
- Biology of opisthobranch molluscs.** Volume 1. 1976. By T. E. Thompson. Ray Society, London. vi + 208 pp., illus. £15.
- † **The biochemistry of blue, snow and Ross' geese.** 1976. By Harold C. Hanson and Robert L. Jones. South Illinois University Press, Carbondale. xviii + 281 pp., illus. \$15.
- The birds of Alberta.** With their ranges in Saskatchewan and Manitoba. 1976. By W. Ray Salt and Jim R. Salt. Hurtig, Edmonton. 2nd edition. 512 pp., illus. \$10.
- † **The bluebird.** How you can help its fight for survival. 1976. By Lawrence Zeleny. Audubon Naturalist Library Book. Indiana University Press, Bloomington. xix + 170 pp., illus. \$7.95.
- The broken archipelago.** Cape Cod and the islands, amphibians and reptiles. 1976. By James D. Lazell. Photographs by Martin C. Michener. Quadrangle (New York Times), New York. xii + 260 pp. \$12.50.
- Butterflies of West Malasia and Singapore.** 1975. By W. A. Flemming. Classey, Faringdon, England. Two volumes, illus. x + 94 pp. + plates, and x + 64 pp. + plates. \$47.
- † **Crows of the world.** An authoritative guide to all 116 species of the crow family, including jays, magpies, rooks, and the raven. 1976. By Derek Goodwin. Illustrated by Robert Gillmor. Cornell University Press, Ithaca, N.Y. vi + 354 pp. \$28.50.
- † **A guide to birdwatching in Mallorca.** 1976. By Eddie Watkinson. Available from M. Philbrick, Box 83, Vashon, Washington. 56 pp., illus. \$3.90.
- Insect clocks.** 1976. By D. S. Saunders. Pergamon, New York. International Series in Pure and Applied Biology. Volume 54. viii + 280 pp., illus. \$18.50.
- Insect flight.** 1976. Edited by R. C. Rainey. Symposium of the Royal Entomological Society of London Number 7. Halsted (Wiley), xii + 288 pp., illus. \$47.50.
- Island biology illustrated by the land birds of Jamaica.** 1976. By David Lack. University of California Press, Berkeley. xviii + 446 pp., illus. \$25.
- Marine insects.** 1976. Edited by Lanna Cheng. Elsevier, New York. xii + 582 pp., illus. \$62.50.
- Marine mussels.** Their ecology and physiology. 1976. Edited by B. L. Bayne. Cambridge University Press, New York. xviii + 506 pp., illus. \$49.50.
- Moths of Southern Africa.** Descriptions and colour illustrations of 1183 species. 1975. By E. C. G. Pinhey. Tafelberg, Cape Town. xii + 274 pp. + plates. \$35.95.
- A natural history of zebras.** 1976. By Dorcas MacClintock. Pictures by Ugo Mochi. Scribner, New York. x + 134 pp. \$7.95.
- Report of the committee on the killing of wild birds for scientific and educational purposes.** 1976. By the Pan-American Society for the Protection of Birds. Available from Dr. J. B. Tatum, Department of Physics, University of Victoria, British Columbia. 14 pp. \$1.
- Social behavior in vertebrates.** 1976. By Anthony Payne. Heinemann, London. vi + 146 pp., illus. \$6.75.
- Sphecids of the world.** A generic revision. By R. M. Bohart and A. S. Menke, in collaboration with H. S. Court, F. D. Parker, E. Grissell, and D. P. Levin. University of California Press, Berkeley. x + 696 pp., illus. \$42.50.
- Where the grizzly walks.** 1977. By Bill Schneider. Mountain Press, Missoula, Montana. \$8.95.
- † **Wintering bald eagle.** 1976. By Donald A. Spencer. National Agricultural Chemicals Association, Washington. ix + 170 pp.
- * **Wolf...kill!** The wilderness called Shunka. 1976. By Marika Lumi. Van Nostrand Reinhold, Scarborough, Ontario. 195 pp. \$9.95.

Botany

- † **Canadian forestry.** The view beyond the trees. 1976. By Charles R. Stanton. MacMillan, Toronto. 70 pp., illus. Paper \$5.95.
- * **Canadian wildflowers.** 1976. By Mary Ferguson and Richard Saunders. Van Nostrand Reinhold, Scarborough, Ontario. 192 pp., illus. \$19.95.
- Common mosses of the Pacific coast.** 1975. By Marion P. Harthill and Irene O'Connor. Naturegraph, Healdsburg, California. 115 pp.

Evolution of crop plants. 1976. Edited by N. W. Simmonds. Longman, New York. 339 pp. \$44.37.

A field guide to Pacific States wildflowers. Field marks of species found in Washington, Oregon, California and adjacent areas. A visual approach arranged by color, form, and detail. 1976. By Theodore F. Niehaus. Illustrations by Charles L. Ripper. The Peterson Field Guide Series, Number 22. Houghton Mifflin, Boston. xxxii + 432 pp. \$10.95.

Flora of Guatemala. 1976. By Dorothy L. Nash and Louis O. Williams. Field Museum of Natural History, Chicago. Fieldiana: Botany, Volume 24, part 12. x + 604 pp., illus. Paper \$18.

Nova Scotia boletes. 1976. By Darryl W. Grund and Kenneth A. Harrison. Bibliotheca Mycologica 47. Cramer, Vaduz, Germany. 283 pp., illus.

* **Ontario weeds.** Descriptions, illustrations and keys to their identification. 1976. By J. F. Alex and C. M. Switzer. Ontario Ministry of Agriculture and Food, Toronto. 200 pp., illus + plates. \$2.50.

Origin and evolution of angiosperms. 1976. Edited by Charles B. Beck. Columbia University Press, New York. 341 pp. \$17.50.

Seeds and fruits of North American Papaveraceae. 1976. By Charles R. Gunn and Margaret J. Seldin. Agricultural Research Service Technical Bulletin Number 1517. United States Department of Agriculture, Washington. 96 pp.

Wild edible plants of the western United States. 1975. By Donald R. Kirk. Naturegraph, Healdsburg, California. 307 pp.

Wild harvest. An outdoorsman's guide to edible wild plants in North America. 1975. By Alyson Hart Knapp. Illustrated by E. B. Sanders. Pagurian, Toronto. 190 pp. \$8.95.

Woody plants of oak openings. 1976. By Bill Easterly. Illustrated by Joy Marburger. Available from author, 506 Harvest Lane, Bowling Green, Ohio. \$6.50.

Environment

Biogeography and ecology in the Canary Islands. 1976. Edited by G. G. Kunkel. Monographiae Biologicae, Volume 30. Junk, The Hague. xvi + 512 pp., illus + plates. Dfl. 160.

Citizens and the environment. Case studies in popular action. 1976. By Lynton K. Caldwell, Lynton R. Hayes, and Isabel M. MacWhirter. Indiana University Press, Bloomington, Indiana. xxx + 450 pp. \$17.50.

* **The ecology of the seas.** 1976. Edited by D. H. Cushing and J. J. Walsh. Saunders, Philadelphia. 467 pp., illus. \$19.50.

Environmental knowing. Theories, research and methods. 1976. Edited by Gary T. Moore and Reginald G. Golledge. Dowden, Hutchinson and Ross, Stroudsburg, Pennsylvania. xxii + 442 pp., illus. \$25.

Insights into environmental education. 1976. By George C. Martin and Keith Wheeler. Oliver and Boyd (Longman), New York. xii + 200 pp. \$11.50.

Proceedings of an international conference on marine parks and reserves. Tokyo, May, 1975. 1976. IUCN Publications New Series, Number 37. International Union for Conservation of Nature and Natural Resources, Morges, Switzerland. 132 pp. Paper \$6.

Resource conservation glossary. 1976. By Soil Conservation Society of America, Ankeny, Iowa. 63 pp. \$5.

Sea life of the Pacific northwest. 1976. By Stefani Hewlett and K. Gilbey Hewlett. Illustrations by Greg Davies. McGraw-Hill, New York. 176 pp. \$14.95.

Miscellaneous

Concepts of species. 1976. Edited by C. N. Slobodchikoff. Benchmark Papers in Systematic and Evolutionary Biology, 3. Dowden, Hutchinson and Ross, Stroudsburg, Pennsylvania. 368 pp. \$10.

The conservation response. Strategies for the design and operation of energy-using systems. 1976. By Lloyd J. Dumas. Lexington (Heath), Lexington, Massachusetts. xviii + 290 pp. \$14.

† **Field photography.** Beginning and advanced techniques. 1976. By Alfred A. Blaker. Freeman, San Francisco. (Canadian distributor Oxford University Press, Don Mills). xxi + 451 pp. + 41 pp. field book, illus. \$19.95.

Richard Harrington's Antarctic. 1976. By R. Harrington. Alaska Northwest. (Canadian distributor, Hurtig, Edmonton). 104 pp., illus. Paper \$9.95.

† **The Shetland way of oil.** Reactions of a small community to big business. 1976. Edited by John Button Thuleprint. Sandwick, Shetland. 134 pp., illus. £2.40.

The world of rocks and minerals. 1976. By Anita Mason. Photographs by Eric Storey. Larouse, New York. xviii + 108 pp. Cloth \$8.95, paper \$4.95.

The world of remote sensing bibliographic index. 1976. Compiled by Paul F. Krumpke. Tensor, Merrifield, Virginia. 600 pp. \$18.

† Assigned for review

* Available for review

The Ottawa Field-Naturalists' Club

Minutes of the Ninety-seventh Annual Business Meeting of The Ottawa Field-Naturalists' Club

The 97th Annual Business Meeting of The Ottawa Field-Naturalists' Club was held in the auditorium of the National Research Council, Sussex Drive, Monday, 19 January 1976. The President, E. C. D. Todd, called the meeting to order at 8:10 p.m., with a quorum of 38 persons present (late arrivals brought this to 47 in all). After the agenda was approved on motion (by R. Taylor, 2nd I. Brodo), the Recording Secretary read the minutes of the 96th Annual Meeting. No errors or omissions were noted, and the minutes were approved on motion (by A. Erskine, 2nd C. Gruchy).

The President called on C. Gruchy to introduce the amendment to the Constitution that was to be voted on; Gruchy explained that its purpose was to meet the legal requirements for recognition of the Club as a "charitable organization" which could issue tax-free receipts for donations received. This amendment, moved and seconded at the last annual meeting, was approved after brief discussion.

R. Foxall, chairman of the Finance Committee, spoke on the financial status of the Club. He explained that, owing to a recent transfer of the Club's funds from a trust company to a bank, and to late receipt of year-end statements from the bank, the Treasurer had been unable to complete compilation of the financial statement in time for this annual meeting. Since the Constitution calls for presentation of this statement at the annual meeting, a motion (by C. Gruchy, 2nd D. A. Smith), empowering Council to receive the financial report instead at the earliest possible opportunity, was approved. The statement will appear in *The Canadian Field-Naturalist* as usual, following acceptance by Council. There was a suggestion that the meeting be held later in January to allow more time for preparation of the financial statement, and an enquiry about the loss of interest incurred by the transfer of invested funds between banking facilities. No estimate of such loss was available, but Foxall emphasized that the transfer had been necessary because of poor service by the former facility and rumours of its financial instability.

E. Todd then introduced the annual report of Council, which is published in *The Canadian Field-Naturalist*, and commented on some of its highlights. These included re-organization following a study carried out by H. MacKenzie; a bequest of \$500.00 from the estate of the late Rowley Frith; the choice offered to individuals of membership in the Club or of subscription to *The Canadian Field-Naturalist* with no membership privileges; the weekend excursion to the St. Lawrence estuary to see whales and seabirds; and the activities of the Conservation Committee, the

Macoun Field Club, and the Centennial Planning Group. Its adoption was moved (by T. Mosquin, 2nd I. Sutherland) and passed.

A. Reddoch, chairman of the Nominating Committee, noted that the committee had followed the guidelines of the draft by-law on nominations in assembling a slate, as follows: President: Ewen Todd; Vice-President: Roger Foxall; Treasurer: Pamela Sims; Recording Secretary: Anthony Erskine; Corresponding Secretary: Patricia Narraway; additional members of Council: Elisabeth Beaubien, William Cody, Albert Dugal, David Gray, Diana Laubitz, Hue MacKenzie, Diane McClymont, Jo Ann Murray, Gerald Oyen, Roger Taylor, Stanley Teeple, Stan Van Zyll de Jong. A request for nominations published in *Trail & Landscape* led to one additional nomination from the general membership: Marshall Ney. On motion (by A. Reddoch, 2nd E. Dickson) all of these nominated were declared elected. R. Foxall expressed his approval of the fact that a nomination had been received from the membership at large, and hoped that more persons would be so nominated in future. L. C. Smith queried the status of past presidents on Council. The consensus was that one year's continuation by an outgoing president helped continuity of operations, that a longer period was unnecessary for that purpose, and that no formal statement of this was required. The President introduced both old and new Council members then present, and thanked outgoing members of Council: J. Dafoe, C. Gruchy, E. Haber, D. Lafontaine, L. Padelford, A. Reddoch, J. Reddoch, A. Sheppard, F. Weekes, H. Williamson, and I. Brodo. He also thanked the auditors for 1975, G. D. Tippet and G. J. Wasteneys, and the refreshments organizer, Catherine O'Keefe.

The auditors for 1976, G. J. Wasteneys and D. A. Potter, were approved on motion (by R. Foxall, 2nd C. Gruchy).

Under new business, D. Gray asked for volunteers to help with various aspects of the program of the Macoun Field Club, especially in connection with excursions, summer trips, and the publication *The Little Bear*. E. Todd introduced T. Mosquin, Executive Director of the Canadian Nature Federation, who was seeking volunteers to help with the organization's conference in Ottawa in May 1976. G. Neville raised questions on financial procedures, and R. Foxall explained that with the increased size of the Club, the work of the Treasurer required as much or more time as several other positions for which honoraria are now granted; the Finance Committee will consider whether the workload should be split or some other procedure would be more appropriate. G. Neville also

queried action on the Club's centennial projects, with particular reference to the possibility of land acquisition. R. Foxall noted that this idea had been considered relatively low in feasibility by members of Council at the special meeting held to consider various proposals for centennial projects, but acknowledged that changed circumstances in future could make it more feasible. In further discussion, it was noted that other proposals for centennial projects dealt with specific items or events, whereas only the idea of acquiring land had been advanced. No particular tract had been proposed for consideration, and Council believed that any tract of a size sufficient to be ecologically viable or recreationally valuable would be so costly as to rule out the possibility of any other major project being undertaken concurrently. G. Neville noted that once donations to the Club were tax-free it would be possible to mount an appeal for funds for this purpose, without committing current funds for the purchase. Problems in land management experienced by other clubs holding land were also

mentioned; M. Stuart noted that a piece of land made available to the Club in the past had later been disposed of after it proved too difficult to maintain. Following a suggestion by T. Mosquin, a consensus was reached that a meeting of the Club be held, with representatives invited from the Federation of Ontario Naturalists' nature reserves program and from other clubs holding land for nature purposes, to discuss the topic in depth. R. Foxall noted that no centennial proposal had yet been finally eliminated from consideration, but that a decision on major projects would be needed before the next annual meeting. H. MacKenzie noted that some projects are already being organized by Council, and such action should be reported in *Trail & Landscape*, without waiting for the next general meeting.

The meeting was adjourned on motion (by I. Sutherland) at 10:00 p.m.

A. J. ERSKINE, Recording Secretary

Report of Council to The Ottawa Field-Naturalists' Club

In 1976, the Centennial Steering Group pointed out that a number of policy decisions were needed from Council so that the planning group was not placed in the position of determining Club policies for the next several years. The Council decisions were these:

1. Focus—both the local and national roles currently assumed by the Club should be continued. Rather more emphasis should be placed on the local role, with the national role performed mainly through *The Canadian Field-Naturalist*.
2. Membership—we should seek more active and involved members. This need not involve any major change in total numbers.
3. Participation—both the public and Club members, but especially the latter, should be able to participate in the Centennial.
4. Nature of observance—the Centennial should include both serious and fun activities.
5. Perspective—the balance is in favor of retrospective topics but there is also strong support for looking ahead.

With these broad guidelines, the Centennial Steering Group is endeavoring to plan a program of activities which will have "something for everyone."

This need for planning led to Council's establishing an Executive Committee, which had been one of the recommendations of the study of Club policies and practices reported last year. Discussions in this

committee should help better to focus subsequent consideration of a topic by Council. Reports of other committees follow, with names of chairmen in parentheses.

Finance Committee. Early in the year, the Finance Committee prepared the budget for 1976. The change in Club policy, whereby a member was provided the choice of either remaining a member or taking an individual subscription to *The Canadian Field-Naturalist*, resulted in a decrease in membership with more money going directly to the journal. Accordingly, the proportion of membership dues used to support *CF-N* was reduced from 50% to 40%. Consideration of the Club's financial picture in 1976 led the Committee to recommend to Council that the fee schedule for 1978 be increased by \$2.00. A bequest of \$250 was received from the estate of Louise Gourlay, an active member of the Club for 24 years. After extended negotiations the Club has finally achieved official status as a "charitable organization"; receipts for income tax purposes can now be issued for donations to the Club. (R. Foxall)

Membership Committee. Members had been offered the choice of becoming Subscribers to *The Canadian Field-Naturalist* without membership privileges in the Club, or continuing as Members of the Club, which entitled them to participate in Club activities, hold

office, vote, and receive *Trail & Landscape* as well as *The Canadian Field-Naturalist*. This choice subsequently resulted in a large drop in membership for 1976, amounting to 36% among non-local members but only 5% of local members (see Table for the comparisons with 1975 figures). Membership application forms continue to be a source of information concerning members who volunteer their skills or specialized knowledge in assisting the Club. Thanks go to all members who volunteered their services. Increased postal rates, printing, and paper costs continue to rise, and this will affect future membership fees. Honorary Membership for W. Earl Godfrey was recommended, and approved by Council. (M. Ney)

Publications Committee. Four issues of *The Canadian Field-Naturalist*, Volume 89(4), and Volume 90(1,2,3), totalling 538 pages, were published since the last report. The last issue, dedicated entirely to raptors, deserves special mention. Articles and notes published during the period numbered 103, including 41 on ornithology, 22 on mammalogy, 14 on botany, 8 on ichthyology, 5 each on herpetology and limnology, and 8 on other subjects. Also 49 book reviews were published. The number of manuscripts submitted to the Editor in 1976 totalled 147, about the same as in the preceding period. We are grateful for grants in support of the journal received from the National Research Council (\$10,000) and the Canadian National Sportsmen's Show (\$750). Five issues of *Trail & Landscape* were published, comprising 140 pages, and covering a wide range of subjects and information of interest to the naturalist. The publication of *Trail & Landscape* was supported by a \$250 grant from the Canadian National Sportsmen's Show. (S. Van Zyll de Jong)

Excursions and Lectures Committee. During 1976 ten monthly meetings and 37 field trips were organized. These latter focussed on the following subjects: birds (20), general (7), botany (5), insects (2), rocks and fossils (2), and amphibians (1). The evening meetings dealt with various natural history topics such as spring wildflowers, mineralogy, and herptiles, and included a panel discussion, organized by G. Neville, on the question of land acquisition. In addition, the Club's annual dinner was held at the Talisman Inn on 20 April. The speakers were John and Janet Foster on "The Wild Regions of Canada." Approximately 300 people attended. The Club also arranged and led a number of excursions for the Canadian Nature Federation meeting in Ottawa in late May 1976. (R. Taylor)

Conservation Committee. Many communications were received seeking information, or transmitting it, or soliciting commentary on proposed plans. Not all those issues deserving comment received it, since time to study or respond was seldom available when needed. The potential activities of this committee are limited only by the time its members can find for it. A brief on the conceptual plan for Gatineau Park, prepared by Allan and Joyce Reddoch after a discussion in committee, was presented at the public hearing in November. Other briefs were submitted on mineral aggregates extraction policy in Ontario and on recreation policy in Canada. Questionnaires or enquiries responded to included the Club's uses of conservation areas designated in the Ottawa-Carleton Region Official Plan, values of the Ottawa Greenbelt, and natural areas in the southeast part of the City of Ottawa. Major planning issues on which no submission was made included the Outaouais Region plan, the N.C.C. interpretation planning for the Greenbelt, Nepean Township's plan for the Jock River corridor, and the City of Ottawa open space study. These mostly involved 50- to 100-page presentations, some making use of data previously made available by the Club, and superficial examination revealed few obvious weaknesses. (A. Erskine)

Macoun Field Club Committee. This year members actively continued the Macoun Club's program for young naturalists, including field trips, meetings, and the Seniors' summer canoe trip. During the summer Len Marhue resigned as chairman, and Jerry Fitzgerald (NMNS) and Arnet Sheppard (OFNC) took over as co-chairmen. The membership remained at about 90. Juniors and Intermediates had weekly meetings and monthly excursions, while the Seniors had both meetings and field trips weekly. The Seniors also helped other groups by conducting nature walks, planning and building nature trails, and surveying new areas. Reports on Club activities will appear in the 1976 "Little Bear." Thanks are due to the National Museum of Natural Sciences (co-sponsor) and to parents of Club members who helped in various ways. (D. Gray)

Education and Publicity Committee. This committee concentrated on providing trip leaders for outside groups, predominantly Cubs, Scouts, and Guides. Macoun Field Club seniors were often effective as leaders. A number of OFNC members braved the mud and sleet to set up telescopes for the two weekends of the Ottawa Duck Club's open house. Owing to confusion about the date of judging at the Ottawa Region Science Fair, it was impossible to award

individual prizes; instead a contribution was made to help the overall winner in natural science to meet travel expenses to the National Science Fair. (A. Sheppard)

The support of the winter bird feeders on Moodie Drive (west end) and Davidson Road (east end) has been continued, and in the fall of 1976 a third feeder near Pink Road in Lucerne was added.

A new birding newsletter named "The Shrike,"

produced by Club members but without Club financing, appeared first in 1976. (S. Van Zyll de Jong)

Thanks are extended to all persons who have served the Club in various ways during 1976.

Compiled from committee reports
and Council minutes by
A. J. ERSKINE, Recording Secretary

Membership of The Ottawa Field-Naturalists' Club

Category	Canadian				Foreign				Totals	
	Local		Other		U.S.A.		Other		1975	1976
	1975	1976	1975	1976	1975	1976	1975	1976		
Individual	451	408	542	324	127	85	09	6	1129	823
Family	198	203	16	23	2	3	0	1	216	230
Sustaining	5	9	1	2	0	0	1	0	7	11
Life	6	7	1	4	1	1	2	2	10	14
Honorary	5	5	4	4	0	0	0	0	9	9
Totals (on 25 Nov./76)	665	632	564	357	130	89	12	9	1371	1087
Changes		-33		-207		-41		-3		-284

Auditor's Report

To: Members of the Ottawa Field-Naturalists' Club

We have examined the balance sheet of The Ottawa Field-Naturalists' Club as at December 31, 1976 and the related Income Statements for the year then ended. Our examination included a general review of the accounting procedures and such tests of the records and supporting vouchers as considered necessary in the circumstances.

In our opinion these financial statements present fairly the financial position of the organizations as at December 31, 1976 and the results of their operations for the year then ended in accordance with generally accepted accounting principles.

(Signed) Geoffrey Wasteneys
D. A. Potter CGA
January 28, 1977

The Ottawa Field-Naturalists' Club Balance Sheet

as at December 31, 1976

Assets

Current

Cash in bank—O.F.N.C.	\$ 2,758.79		
Cash in bank—C.F.N.	21,537.14	\$24,295.93	
Bills receivable		3,737.01	
Accrued interest receivable		7,896.15	
Prepaid expenses		4,863.00	\$40,792.09

Fixed (at cost)

Furniture, fixtures and equipment	529.50		
Less: accumulated depreciation	390.70		138.80

Investments and securities

Canada Savings Bonds			10,700.00
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Liabilities and Equity of Surplus

Current liabilities

Income received in advance	\$ 6,223.50		
Accounts payable	6,948.59		\$13,172.09

Equity of surplus

Balance January 1, 1976	26,747.73		
Add: net income for the year	11,711.07		38,458.80
			\$51,630.89

(Signed) Geoffrey Wasteneys, Auditor
D. A. Potter, Auditor
Pamela J. Sims, Treasurer

The Ottawa Field Naturalists' Club Statement of Profit and Loss— CF-N

for the year ended December 31, 1976

Revenue

Membership income	\$ 4,296.13	
Subscription income	10,775.30	
Grants—N.R.C.	\$10,000.00	
—Canadian Sportsmen Show	750.00	10,750.00
Reprints	9,918.25	
Plates and tab settings	3,053.00	
Extra pages and authors' costs	5,019.12	
Back numbers	2,727.45	
Special publications	300.00	
Interest income	1,606.83	\$48,446.08

Less: cost of publications

Volume 90 (1, 2, 3, 4)	26,034.72	
Plates and tab settings	112.00	
Reprint costs	4,589.29	30,736.01

Gross profit on operations 17,710.07

Less: operating expenses

Bank charges and interest	21.41	
Circulation	900.11	
Office assistant	1,518.00	
Postage	1,819.32	
Printing and stationery	857.07	
Editing—Contracts	890.00	
—General expenses	739.74	
Honoraria	1,502.00	82,247.65

Net Income \$ 9,462.42

The Ottawa Field Naturalists' Club Statement of Profit and Loss— O.F.N.C.

for the year ended December 31, 1976

Net income from CF-N		\$9,462.42
Other income		
Membership income	\$6,451.20	
Donations and grants	515.94	
Sale income	8.00	
Subscriptions <i>T & L</i>	173.75	
Interest income and dividends	660.10	7,808.99
		\$17,271.41
Less: cost of publications		
<i>T & L</i> Volume 10	2,079.15	
Circulation	120.80	
Office and editorial	61.19	
Honoraria	440.00	2,701.14
Gross profit on operations		14,570.27
Less: operating expenses		
Council expenses	964.79	
Printing and stationery	56.33	
Special activities	72.68	
Committee expenses—Membership	857.22	
—Excursions and Lectures	190.00	
—Bird Records	19.98	
—Bird Feeder	290.50	
—Macoun Field Club	66.57	
Baldwin Scholarship	103.00	
Bank charges and interest	3.43	
Depreciation expense	34.70	
Accounting services	200.00	2,859.20
Net Income		\$11,711.07

Instructions to Contributors

Content

The Canadian Field-Naturalist is a medium for publication of original scientific research papers in all fields of natural history that have relevance to Canada. As the journal has a flexible publication policy, items not covered in the traditional sections (Articles, Notes, Letters, News and Comment, and Book Reviews) can be given a special place provided they are judged suitable. Naturalists are also encouraged to support local natural history publications.

Manuscripts

Please submit, in either English or French, three **complete** manuscripts written in the journal style. The research reported should be original. It is recommended that authors ask qualified persons to appraise the paper before it is submitted. Also authors are expected to have complied with all pertinent legislation regarding the study, disturbance, or collection of animals, plants, or minerals.

Type the manuscript on standard-size paper, if possible use paper with numbered lines, double-space throughout, leave generous margins to allow for copy marking, and number each page. For Articles, provide a running head, a bibliographic strip, an abstract, and a list of key words. These items are optional for Notes. Generally words should not be abbreviated but use SI symbols for units of measure. Underline only words meant to appear in italics. The names of authors of scientific names should be omitted except in taxonomic manuscripts or other papers involving nomenclatural problems. Authors are encouraged to use "proper" common names (with initial letters capitalized) as long as each species is identified by its scientific name once.

Although we prefer the names of journals in the Literature Cited to be written out in full, these may be abbreviated following the **Bibliographic Guide For Editors & Authors**, The American Chemical Society, Washington, D.C. (1974). Unpublished reports should not be cited here. Next list the captions for figures (numbered in arabic numerals and typed together on a separate page) and present the tables (each titled, numbered consecutively in arabic numerals, and placed on a separate page). Mark in the margin of the text the places for the figures and tables.

Extensive tabular or other supplementary material not essential to the text, typed neatly and headed by the title of the paper and the author's name and address, should be submitted in duplicate on letter-size paper for the Editor to place in the Depository of Unpublished Data, CISTI, National Research Council of Canada, Ottawa, Canada K1A 0S2. A notation in the published text should state that the material is available, at a nominal charge, from the Depository.

The **CBE Style Manual**, 3rd edition (1972) published by the American Institute of Biological Sciences, is recommended as a guide to contributors. **Webster's New International Dictionary** and le **Grand Larousse Encyclopédique** are the authorities for spelling.

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comments and constructive recommendations. Almost all manuscripts accepted for publication have undergone revision—sometimes extensive revision and reappraisal. The Editor makes the final decision on whether a manuscript is acceptable for publication, and in so doing aims to maintain the scientific quality and overall high standards of the journal.

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Volume 91, Number 3

July-September 1977

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All material intended for publication should be addressed to the Editor:

Dr. Lorraine C. Smith, R.R. 3, Stittsville, Ontario, Canada K0A 3G0

Cover: Lesser scaup duckling photographed by Robert J. Long at Tofield, Alberta. See article on page 248.

The Canadian Field-Naturalist

Volume 91, Number 3

July-September 1977

Reporting of Range Extensions

Some time ago, I wrote to the Editor, Lorraine C. Smith, to ask whether some consideration could be given to the publication annually in *The Canadian Field-Naturalist* of one annotated list of range extensions. This would replace the large number of small notes that we presently publish. It seemed to me at the time, and it still does, that there is a disproportionately large amount of work and cost associated with these notes relative to their apparent value. That my feelings are not unique is shown by the new policy of another Canadian journal, the *Journal of the Fisheries Research Board of Canada (JFRBC)*, which refuses to publish range extensions unless these are specifically parts of major zoogeographic studies. Indeed, as indicated in the Editorial by J. C. Stevenson, Editor of *JFRBC* (1976, 33(12): 2697-2698), the crisis of costs, labor, and steadily increasing numbers of manuscripts being submitted, has required not only that range extensions be refused but also "case history studies." These latter are those which may provide new knowledge but are purely descriptive or are not unique contributions. A question arises, how should publication of these studies be handled? For example, where and in what format should they be published, if at all? The very crisis that caused *JFRBC* to change its policy certainly affects *The Canadian Field-Naturalist*; in fact, such cost, labor, and manuscript-deluge factors are likely to be even more serious for our Journal in the long term because of its societal rather than government support, and the volunteer nature of its labor force. I do not wish to decry the scientific value of these kinds of reports but every editor is faced with making choices among manuscripts when resources are limited.

One way of cutting costs while continuing to publish range extensions is to present an annotated list annually. Each entry in such a list would contain (1) the species, (2) the new range, (3) any special sampling methods, (4) any special references, and (5) the author(s) of the extension. Author credit is extremely important since many biological scientists' main concerns are restricted to the publication of range extensions. I see no reason why inclusion in the annotated list should be judged any less worthy than a short, anecdotal note. In fact, I suspect that the list would contain far more entries than would normally be published because of the ease of preparation. As is now the case, only significant extensions would be included in the list. Such significance would be judged by the current method, i.e., by the appropriate Associate Editor and one or more other persons knowledgeable in the field. Furthermore, such lists would reduce the literature-searching effort required for zoogeographic or phytogeographic studies.

There are obvious difficulties related to the procedure for establishing an annual list. For example, these would include setting up a suitable format, delegating responsibility for checking the significance of extensions, editing, and deciding on which issue in the year, etc. It has been the policy of this Journal to direct extensive tabular material or other supplementary material not essential to the text to the Depository of Unpublished Data, Canadian Institute for Scientific and Technical Information (CISTI), National Research Council of Canada. Many range extensions are little more than a casual observation, not worthy of *individual* publication, but certainly contributing to the overall picture of a species' distribution. I propose that the raw data for each extension be placed in the Depository; publication would take place in the annual list, as above.

The publishing of an annual list of range extensions as a summary of the range data submitted to the Depository has several advantages: (1) the list would contain only the crucial elements of the range information, with the raw data available on request from the Depository; (2) publication costs would be considerably reduced through the reduction in pages and editorial effort required, and

(3) the nominal cost of retrieval of information from the Depository would be charged only to those who need the information, not to the entire readership of *The Canadian Field-Naturalist*. In spite of the page charges currently levied, costs are not being matched by income; grants from the National Research Council of Canada presently cover the deficit but these funds could be reduced at any time. I do not want *The Canadian Field-Naturalist* to be forced to discontinue publication of range extensions (and other small notes) entirely, as has *JFRBC*. I believe the annual annotated list of range extensions is the answer to the problem.

There is one final point to be made. I see the annotated list as a first step toward a new condensed method of reporting science as a whole. Much of what is published today is highly repetitive because the author cannot assume adequate access to the literature for all his readers. There are major efforts under weigh to computerize not only literature searching (e.g., Canadian On-Line Enquiry (CAN/OLE) of CISTI) but whole libraries as well. Once such computerizing is accomplished, the pressure on resources for classical publication should drop considerably; not only will the computerized journal be able to handle final reports of research work, but complete tables of raw data with the complete details of acquisition methods can be stored and made readily available to any investigator. Far too much raw data and information on methods dies in investigators' files. The range extension list with the use of the Depository for details is the first step in preventing such deaths.

DAVID P. SCOTT,
Associate Editor

Freshwater Institute, 501 University Crescent, Winnipeg, Manitoba R3T 2N6

Editor's Comments and Policy

Commentary on Reports of Range Extensions

Observation of a species of plant or animal in a locality from which it has never before been reported and that is outside the known range delimited by lines joining the outermost localities of its previous known occurrence may come about because no naturalist has ever visited the area at the appropriate time or utilized the appropriate collecting techniques there. There is not necessarily any extension of the range involved, but our knowledge of the range of the species has indeed been expanded (i.e., an extension of the known range). Some observations of species not previously known to occur in well-studied or other areas, however, do document real extensions of ranges. Both types of observations are significant and, when supplemented by specimens or other evidence, are the raw material for many important distributional, biogeographical, and taxonomic studies. Material evidence is usually deposited in museums and herbaria and in certain cases the new knowledge about the occurrences is communicated to others via published reports of range extensions of both types outlined above.

Among many journals that have documented range extensions, *The Canadian Field-Naturalist* has had a long and reputable history of publishing range extensions as Notes as our knowledge of the distribution of the flora and fauna of Canada has unfolded. Many of the basic distributional data for major Canadian publications such as Godfrey's *The birds of Canada* and Banfield's *The mammals of Canada* were first published in the pages of *The Canadian Field-Naturalist*.

Because of the greatly increased number of competent naturalists/biologists and their greater mobility and improved technology for collecting and observing, the number of reports of range extensions submitted to journals has grown considerably in recent years. For various reasons, many journals have found the matter troublesome and some have developed definite policies in this regard. For example, *Herpetological Review* uses a standardized brief format for reporting range extensions while *Copeia*, *Herpetologica*, and the *Journal of the Fisheries Research Board of Canada* will no longer publish such reports.

The method of reporting range extensions in *The Canadian Field-Naturalist*, i.e., usually in anecdotal form as Notes, has been reviewed from time to time but up to now no specific action has been taken to change it. With the subject having been revived recently by Associate Editor David Scott, however, it has already been the subject of considerable discussion with interested persons. Therefore, it seems appropriate at this point for me to comment on the general subject of publication of reports of range extensions and the advantages of each of the two formats, and to outline a new, perhaps interim, policy for this Journal that seems to form a reasonable compromise. As with all editorial policy matters, this policy on reporting range extensions will be subjected to frequent reconsideration and will be altered if circumstances warrant.

Much of natural history consists of historical and ecological biogeography. Distribution bears on biogeography and may also be significant in interpreting effects of climatic changes and changes caused by pollutants and other works of man. Often properly qualified speculation about the causation of distribution patterns is the logical antecedent for subsequent in-depth studies. Canada is a very large country and only a small number of biologists and naturalists are seriously engaged in distributional work. Certainly there is a definite need to encourage proper documentation of range extensions. One assumes that authors reporting new and significant range extensions have looked up the pertinent literature and consulted others knowledgeable in the field who might have similar records so that a complete and competent report is submitted. Sometimes a purported range extension reflects a visit to an area surrounded at a greater or lesser distance by known parts of the range of the species in question, so the "new" observation might have been predicted from a knowledge of the geography, and the habitat requirements and dispersion abilities of the species. Of course, it is generally recognized that not every range extension and distributional report should be

published in *The Canadian Field-Naturalist*. Reports that are of interest only locally should be directed to regional bulletins or local naturalists' publications.

It is evident that discoveries of noteworthy range extensions often trigger off further studies of other aspects of the biology of the respective species. Often too the significance of a first record becomes apparent only with the passage of time, as either more records accumulate to show a pattern, or the uniqueness of the original record is supported by the failure to repeat it. Perhaps the main real values of publishing the first record rather than merely depositing it at a museum or other institution are that it alerts other observers to the possibility of finding the entity in that area or stimulates them to search for it in related similar areas where it has never been recorded before.

In a memorandum dated 27 April 1976 addressed to our Associate Editors and some other persons known to be concerned with our editorial policies, I asked for comments on David Scott's suggestion of having a single annual annotated list of new range extensions (i.e., new distributional records for both plants and animals that represent significant extensions over the currently known ranges) to replace the series of Notes that we now publish. The responses to my memorandum showed rather divergent views — some were in complete agreement with David Scott but others were adamantly opposed. I particularly thank the many people who considered the problem and were kind enough to write to me about it; I have borrowed freely from their written views in the sections that follow.

Reasons for the Anecdotal Note

There is a peculiar joy one experiences when one finds a species where nobody has ever seen or collected it before, and publication by a journal of one's first short note documenting the experience may be the spark that sets off a lifetime of scientific observation and publication. It can lead to further studies of the morphology, taxonomy, ecology, and biogeography of the organisms observed. One can attempt to answer whether there is a relict population, whether this is an ecologically limited rarity, an inadvertent introduction likely or unlikely to become established, or a recent advance by a species.

Publishing reports of significant range extensions has been a valid function of *The Canadian Field-Naturalist*. For many readers these distributional studies are the papers of greatest direct interest and usefulness as well as the easiest to comprehend. These papers clearly contribute to their enthusiasm for natural history. Not only does it whet the amateur's appetite to read these reports but it also encourages him/her to put his/her own observations on record. This is one field where amateurs can make meaningful contributions to natural history. Will others still be sufficiently encouraged to report similar or complementary information if we publish merely annual annotated lists? If we delete the anecdotal Notes, will we lose interest and membership at the amateur level? This Journal has a long-term reputation for being an important outlet for the work of naturalists and it would be a pity to terminate this relationship.

Perhaps a long list of range extensions, incorporating several or many diverse groups of animals and plants, would pass unnoticed by most workers who scan titles in Tables of Contents. Also formal lists are dull and not of interest to the general reader. Papers, no matter how short, are indexed by abstracting services while it is unlikely that entries in annotated lists would be (they *would* be included in *The Canadian Field-Naturalist* volume index). A formal Note is a publication and there may be an incentive to an author to put his observations on record in order to add one more publication to his list.

An annotated list might contain information too minimal to establish adequately the significance of a record especially where circumstances of the find, habitat, weather, and associated species were highly significant. Other sorts of information (e.g., maps) are lost. Many papers do not deal strictly with range extensions but may also provide information as to how a species is faring under extreme conditions or how it may be distinguished from related species. Moreover, such papers can assess the validity of previous reports.

Reasons for the Annotated List

With many species being found farther and farther from their previously known ranges, publishing these findings as papers, however short, could get out-of-hand. The present wave of ecological surveys and general interest in ecology and natural history could lead to a flood of papers, each with a review of past records and a new distribution map for publication, especially if other journals will no longer publish them. Furthermore, the proliferation of brief distributional Notes which individually may be of uncertain significance has tended to make some view *The Canadian Field-Naturalist* as "unscientific."

The annotated list saves space yet still makes the pertinent information available, saves expensive page and labor costs, and gets the report into circulation. There is no reason that each entry in the list couldn't be properly indexed by abstracting services or other information retrieval systems. Furthermore, each entry should be considered as a valid publication for its authors as it contains significant, new scientific information.

The ease of preparation of an entry for the annotated list may well encourage the publication of a greater number of interesting records. Several scientists and amateurs have such potential records to publish but haven't the time nor inclination to write a research Note on a few interesting but often unrelated species.

Editorial Policy on Reports of Range Extensions

To me the best interim approach to the problem is a compromise to utilize the advantages of *both* methods of publishing important records of extensions of species' ranges — traditional papers for certain more important records that warrant it and the new annotated list proposed by David Scott for other significant range extensions. Each report should be judged on its own merits. If reviewers, who are workers in the discipline, feel that a trivial extension is involved, then it clearly shouldn't be published. If it is of "moderate" interest then it could fit into the suggested annotated list. If it has broader implications, then a full paper is warranted. The traditional Notes with full documentation could be maintained mainly for very unusual records requiring special discussion, e.g., major range extensions with ecologically important notes and taxonomic and biogeographic comments. Probably most records, however, would be meaningful with a minimum of published documentation and discussion: their highlights would be published in compact form in the annotated list that *The Canadian Field-Naturalist* will henceforth use. Supplementary data can be placed in the Depository of Unpublished Data, CISTI.

Because *The Canadian Field-Naturalist* covers a wide variety of disciplines concerned with natural history, it is difficult to devise a rigid format and guidelines for reporting range extensions that are exactly the same for all organisms and situations. Therefore, the ones that I am now presenting will be somewhat *flexible* and may have to be modified somewhat as we begin to publish these annotated lists. I propose to publish the annual list in the July/September issue with the first listing in 1978. If it is warranted, we will publish the lists more frequently. The list will initially be called "Reports of Significant Range Extensions." The following format should be followed by those submitting contributions to the list.

1. Phylum, class, order, family (for systematic organization of the list).
2. Species. The scientific name and the vernacular name if commonly used. Refer to pages 119–120 of Editorial Policy (Canadian Field-Naturalist 91(2): 117–121. 1977) for this Journal's policy on nomenclature.
3. New Record. State the precise locality (with coordinates), the direction and distance from the nearest previously known locality, and the date.
4. Special Circumstances. Describe any special collecting techniques or means of observation.
5. Evidence. State the nature and location of specimen(s), photographs, or other supporting material. State whether supplementary material has been submitted to the Depository of

Unpublished Data, CISTI*. Supporting data could include description for identification, museum accession numbers, measurements, names and addresses of other observers, etc.

6. Significance. If pertinent, include one or two brief sentences about the significance of the range extension (e.g., habitat, biogeographic relation with other members of the genus, reproductive data, whether a stray or a breeding population).
7. References. Include only literature immediately pertinent to the range extension.
8. Author(s). Include name(s) and complete address(es).

I sincerely hope that *The Canadian Field-Naturalist's* long and admirable tradition of promoting communication among professional biologists and amateur naturalists will continue with the use of the new dual system of reporting range extensions. I will be most interested to learn our readers' responses to David Scott's editorial and to my commentary and the new editorial policy outlined above.

LORRAINE C. SMITH,
Editor.

*A submission for the Depository of Unpublished Data, CISTI, National Research Council of Canada, Ottawa, Ontario K1A 0S2, should be typewritten. Two copies are required and they must be submitted by the Editor. The submission should be headed "Supporting Data for Reports of Significant Range Extensions" followed by "Published in *The Canadian Field-Naturalist*" (leave space for the volume number, issue number, page, and year to be added). Then give the name(s) and address(es) of the author(s) and the supporting data.

Shorebirds at Long Point, Lake Erie, 1966–1971: Seasonal Occurrence, Habitat Preference, and Variation in Abundance¹

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Bradstreet, Michael S. W., Gary W. Page, and W. Gavin Johnston. 1977. Shorebirds at Long Point, Lake Erie, 1966–1971: seasonal occurrence, habitat preference, and variation in abundance. *Canadian Field-Naturalist* 91(3): 225–236.

Abstract. Occurrence, habitat preference, and seasonal and annual variations in shorebird abundance at Long Point, Lake Erie, from 1966 to 1971 are documented. Significant declines in shorebird numbers were noted between 1967 and 1971 for species that fed at pools on the beach, but not for species that fed along the interface between the beach and Lake Erie. It is suggested that a change in Lake Erie's water level was the most important factor causing the variations in shorebird numbers at Long Point. Some implications of habitat deterioration along shorebird migration routes are discussed.

Introduction

Weir and Cooke (1976) summarize census information on autumn shorebird migration at Kingston, Ontario. In this paper we present information from similar counts at Long Point, Ontario, to elaborate on the details of migration timing given by Weir and Cooke. In particular, we present details on differential age migration and focus attention on the importance of habitat quality in maintaining shorebird numbers at migration staging areas. We also include data on spring migration.

Study Area

Long Point is a 32-km peninsula projecting east from the north shore of Lake Erie (Figure 1). Cattail marsh (*Typha* spp.) forms most of the peninsula's north shoreline; sand beach forms most of the south shoreline. The interface between the beach and the lake was one of two easily discernible habitats where many shorebirds fed; the other was the edge of shallow pools on the beach. During the study period, pools varied in length from 10 m to 400 m, in width from 5 m to 35 m, and ranged in depth up to 1.2 m. Some opened into the lake but others were separated from it by as much as 180 m of sand beach. Ponds between sand dunes north of the south beach were deeper and more stable

than beach pools. In contrast to the sparsely vegetated beach pools, ponds were bordered with sedges (Cyperaceae) and grasses (Poaceae), and were used by relatively few shorebirds.

Methods

From 1966 to 1971 volunteers and staff of Long Point Bird Observatory counted shorebirds along portions of the south beach. In 1967, 1969, and 1971 at least one of the authors was on most counts. Counts were made on several days each week from early April until late October (less frequently later) along the easternmost 8 km of south beach in 1966 and 1967 and along the easternmost 20 km from 1968 to 1971. In all years, weekly counts were usually made on the entire south beach (32 km). Observers identified and counted birds with 20× spotting scopes and 6–8× binoculars. Whenever possible, plumage characteristics described by Roberts (1955) were used to separate immature birds (less than 1 year old) from adults (more than 1 year old). Throughout the study many shorebirds were netted and banded; their plumage characteristics were used to verify field-aging techniques. On most censuses in 1967, 1969, and 1971 the habitat on which shorebirds fed was recorded. Since many observers were unable to distinguish between the two species of dowitchers (*Limnodromus* spp.), we did not separate the species in this paper. Based on our own observations,

¹A contribution of the Long Point Bird Observatory.

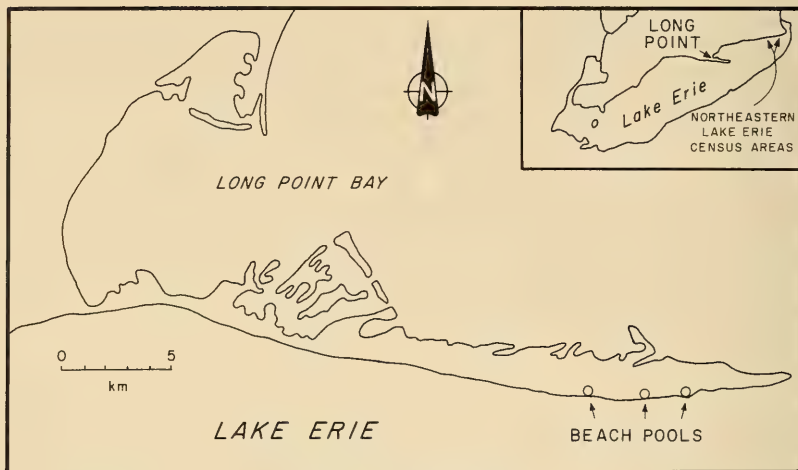


FIGURE 1. Map of study area.

however, we believe that most dowitchers observed at Long Point were Short-billed Dowitchers (*L. griseus*) except for a few late-occurring adults and immatures that were probably Long-billed Dowitchers (*L. scolopaceus*).

To describe shorebird habitat preferences we tabulated count data by habitat in three periods, 1 April–30 June, July–August, and September–October. The numbers of censuses in each period were 65, 54, 43 respectively in 1967; 23, 47, 59 in 1969; and 8, 46, 31 in 1971.

Air temperatures and wind velocities used in this paper are from the records of the weather station at the tip of Long Point; Lake Erie water temperatures (Table 1) were adapted from Richards et al. (1969) and Irbe (1972); Lake Erie water levels (Table 2) were taken from daily summaries of the Port Colborne gauge (northeast of Long Point) provided by the Environmental Data Service, Oceanography Branch, Environment Canada.

Gillies (1959), Richards (1965) and others have noted that the eastern basin of Lake Erie is subject to temporary oscillation of water levels when winds are from the southwest. These seiches are responsible for the flushing of beach pools at Long Point. We developed an index of beach pool flushing to indicate the relative flushing frequency at different seasons and in

different years. The index, presented in Table 3, is the number of 4-h intervals in which a southwest wind of greater than 32 km/h was recorded at Long Point.

Results

On weekly counts of the entire south beach, shorebirds within the more frequently censused 8-km segments in 1966 and 1967 and 20-km segments in 1968 to 1971 made up about 80% of all birds counted on the beach. Therefore, shorebird numbers in the smaller, more frequently censused areas were fairly representative for the entire beach. Although we did not systematically census inland ponds, on frequent visits over the 6

TABLE 1—Mean air and Lake Erie water temperature at the tip of Long Point

Period	Mean temperature (°C)	
	Air ¹	Lake ²
Apr.–Jun.	11.3	9.4 ³
Jul.–Aug.	21.3	19.3
Sept.–Oct.	16.9	14.8

¹Air temperatures are means of daily mean temperatures recorded by the weather station at the tip of Long Point, 1941 to 1970.

²Lake temperatures are means of monthly readings and cover the period from May to October, 1966 to 1969 (Richards et al. 1969; Irbe 1972).

³Average of May and June values only.

TABLE 2—Mean Lake Erie water level recorded at Port Colborne, Ontario¹

Year(s)	Metres above sea-level
1912-1965	173.81
1966	173.74
1969	174.23
1970	174.10
1971	174.15

¹Water levels are means of mean daily levels for each month of the year(s). Port Colborne is about 80 km NE of the tip of Long Point.

TABLE 3—Index of beach pool flushing at Long Point¹

Year	Index		
	Apr.-Jun.	Jul.-Aug.	Sept.-Oct.
1967	12	0	70
1969	2	12	57
1971	78 ²	65	97

¹Index is the number of 4-h intervals in which a southwest wind of greater than 32 km/h was recorded.

²May and June data only (April records not available).

years we noted Common Snipes (*Capella gallinago*), Greater Yellowlegs (*Tringa melanoleuca*), Lesser Yellowlegs (*T. flavipes*), Least Sandpipers (*Calidris minutilla*), and dowitchers feeding in them. But all of the above species except the Common Snipe were much more abundant on beach pools than on inland ponds.

Seasonal Variation in Abundance of Common Shorebirds

Seasonal occurrence of common shorebirds was graphed by grouping the count data into 5-day intervals with 1-5 January as the first interval (Figure 2a, b). The highest census total for each 5-day interval, regardless of the year and area censused, was used to graph the seasonal occurrence of each species.

Figure 2a and 2b shows that the distributions of species nesting in the area (Piping Plover (*Charadrius melodus*), Killdeer (*C. vociferus*), American Woodcock (*Philohela minor*), Spotted Sandpiper (*Actitis macularia*), and possibly Common Snipe) are continuous throughout the spring, summer, and autumn although numbers

of some of these species increase dramatically during migration.

All other species occur only as migrants and exhibit one of three abundance patterns (Figure 2a, b). In one pattern large numbers of birds occur in the spring but not in autumn (Ruddy Turnstone (*Arenaria interpres*) and Whimbrel (*Numenius phaeopus*)); a contrasting pattern shows smaller numbers in the spring than in the autumn (Semipalmated Plover (*Charadrius semipalmatus*), Black-bellied Plover (*Pluvialis squatarola*), Baird's Sandpiper (*Calidris bairdii*), Least Sandpiper, dowitcher spp. and Sanderling (*C. alba*)); and in the third pattern there is no marked numerical difference between spring and autumn (Greater Yellowlegs, Lesser Yellowlegs, Pectoral Sandpiper (*Calidris melanotos*), Dunlin (*Calidris alpina*), and Semipalmated Sandpiper (*Calidris pusilla*)). The period of occurrence of these migrant species is longer in autumn than in spring, partially because adult shorebirds of most species migrate south earlier than immatures (Figure 2a, b). The Dunlin is an exception in that peak autumn numbers of adults and immatures occur simultaneously at Long Point.

Annotated List of Uncommon Shorebirds

An annotated list of the uncommon species observed during the study was prepared from adequately documented records in the Observatory's log and the authors' field notes.

AMERICAN GOLDEN PLOVER. *Pluvialis dominica*. One to four Golden Plovers were present at the tip of Long Point from 23 to 30 March 1968, and on 31 March an additional six individuals appeared, giving a high count of 10 birds for the study. The only other spring record was a single bird on 13 April 1968. Autumn records of from one to eight Golden Plovers occurred between 22 August and 8 October. At least two autumn birds were adults, one on 25 August 1969 and another that stayed from 3 to 6 September 1969. Snyder (1931) did not see Golden Plovers at Long Point, but Townson (1928) recorded that they migrated on two nights in October 1927. Hussell (1965) and Hussell et al. (1966) recorded three Golden Plovers at Long Point on each of 22 September and 27 October 1962, 17 September 1963, and 21 September 1964.

UPLAND SANDPIPER. *Bartramia longicauda*. Single birds were seen on 6 May 1971, 29 May 1969, 26 June 1966, and 6 August 1968. Snyder (1931) did not record

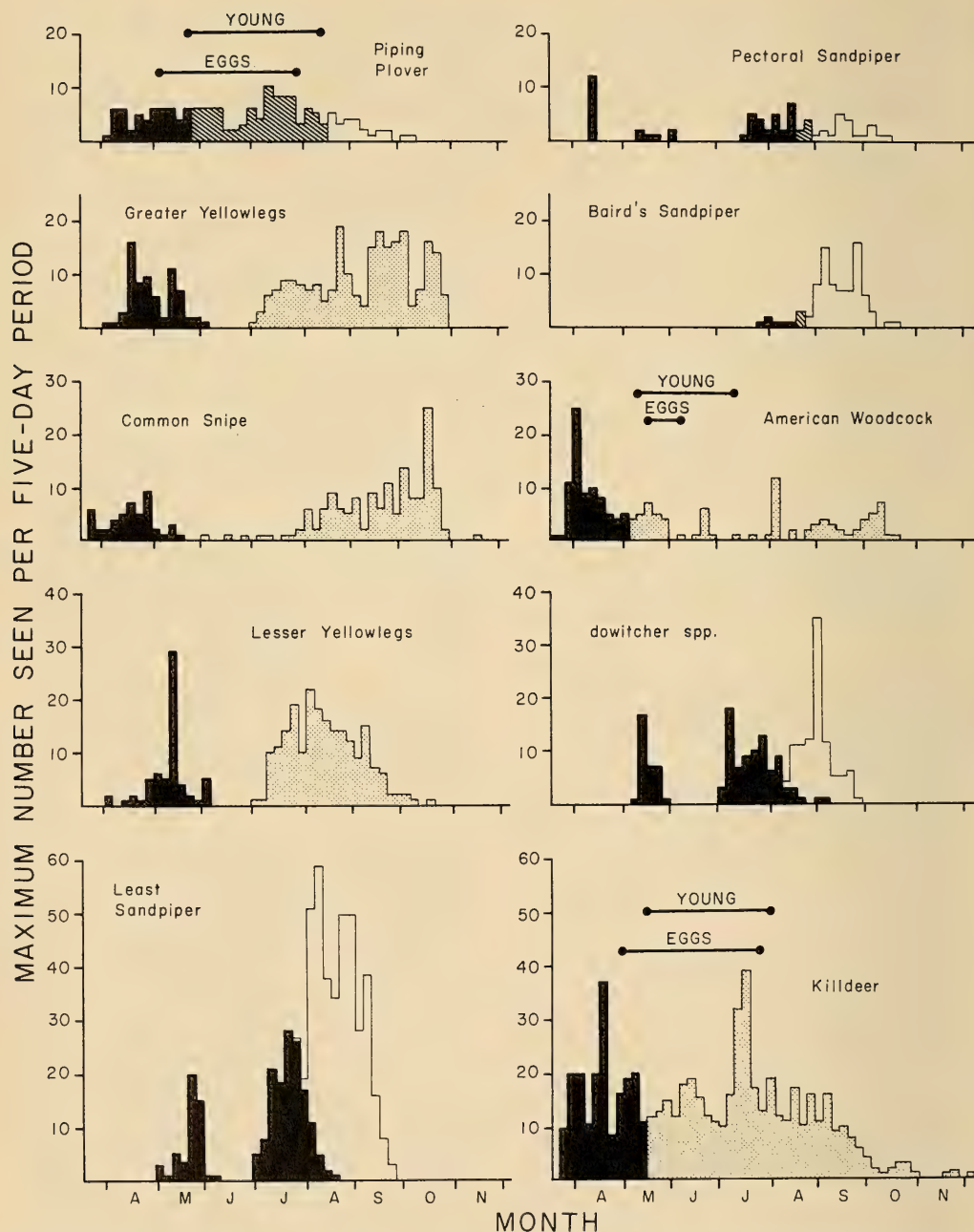


FIGURE 2a. Occurrence of common shorebirds at Long Point, 1966 to 1971. Solid black areas of the graphs represent adult birds; clear areas, immature birds. Hatching indicates the presence of both adult and immature birds but gives no information on their relative abundance. Stippling indicates that no information on the age structure of the population is available. Horizontal lines represent periods when nests were known to contain eggs and when non-flying young were found. The abscissa covers 53 five-day intervals from 17 March to 4 December.

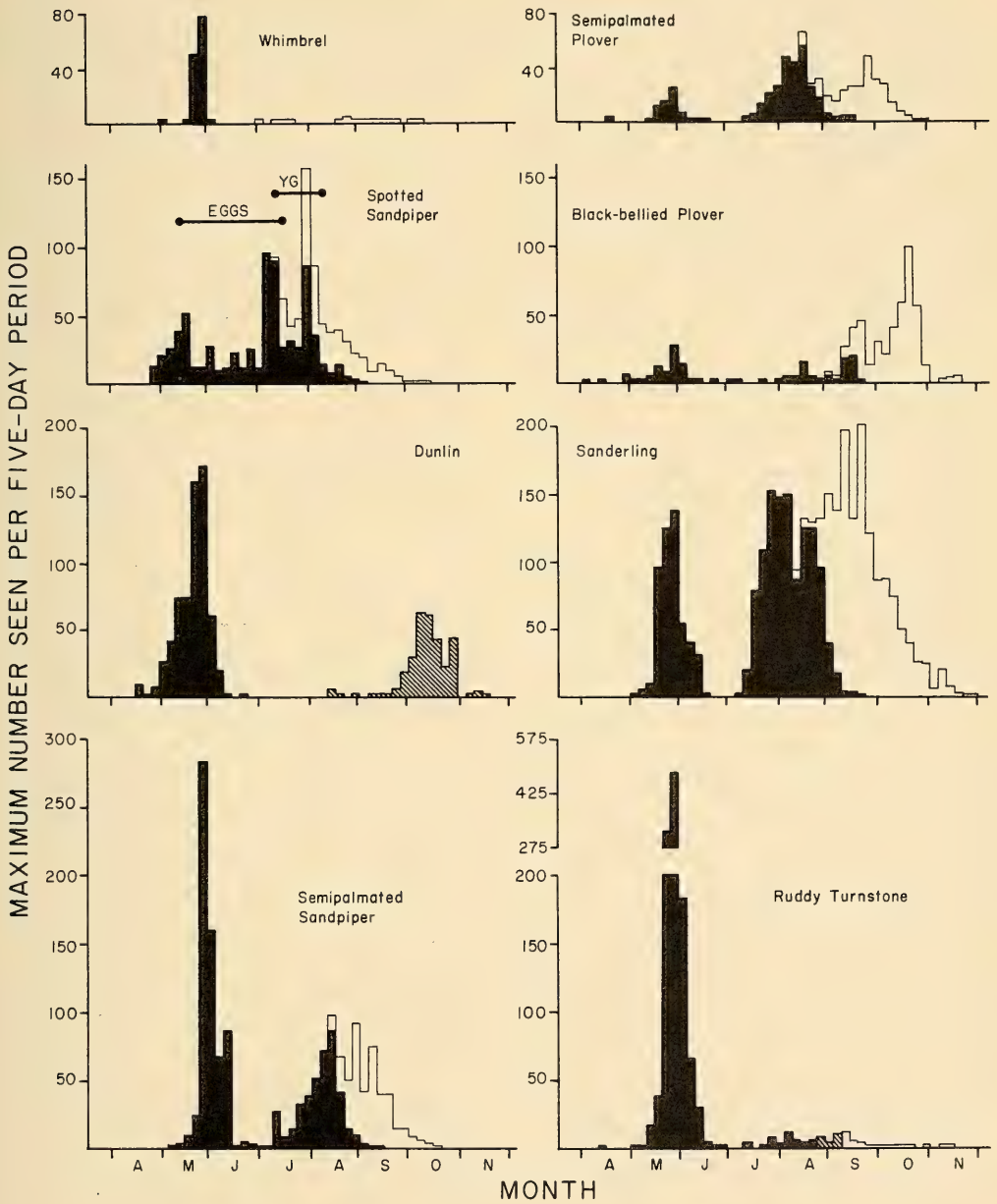


FIGURE 2b. Occurrence of common shorebirds at Long Point, 1966 to 1971. Note that the ordinate axes in these graphs are different in scale than those in Figure 2a.

this species at Long Point, but Hussell (1965) noted one on 21 May 1963. Single birds were also seen on five occasions from 21 April to 24 May 1965 (Hussell et al. 1967).

SOLITARY SANDPIPER. *Tringa solitaria*. A few Solitary Sandpipers were seen during every year of the study. Spring records were from 19 April to 19 May; autumn records from 11 July to 3 October. One or two individuals were recorded on each occasion except on 11 and 18 August 1967 when three birds were seen on the beach pools. Snyder (1931) and Hussell et al. (1966) report records within the dates we give.

WILLET. *Catoptrophorus semipalmatus*. Three Willets were seen during the spring, one on 23 May 1967, one on 27 May 1971, and one on 15 June 1966. At least one Willet was seen every autumn; the extreme dates were 25 July and 2 October. A flock of 10 Willets on 7 August 1969 was the only instance when more than one individual was seen in a day. In total, 26 Willets were seen at Long Point during the study. Hussell et al. (1967) report a Willet at Long Point on 1 and 2 September 1965.

RED KNOT. *Calidris canutus*. In spring, Red Knots occurred from 22 May to 11 June. On 28 May 1967, 44 were observed on the beach pools; this was the highest count for the study. In autumn, Red Knots were seen from 12 August to 26 October; the highest fall count was six birds on 22 August 1968. Fewer than 12 Red Knots occurred during any one autumn and most of these were immatures. Snyder (1931) collected eight Red Knots at Long Point in the spring of 1927. Hussell et al. (1966, 1967) report records within the dates we give except for an earlier fall record of nine birds on 8 August 1965.

PURPLE SANDPIPER. *Calidris maritima*. On 28 May 1971 this uncommon migrant was seen on the beach 10 km west of the tip of Long Point. The only autumn records were a single bird banded on 15 November 1970 and five individuals sighted on 21 November 1966. Hussell (1965) reports one on 11 November 1962 and three on 30 October, two on 25 November, and one on 5 December 1963.

WHITE-RUMPED SANDPIPER. *Calidris fuscicollis*. White-rumped Sandpipers were seen infrequently in the late spring. Two were observed on 29 May 1966, one on 31 May 1968, one on 10 and 11 June 1967, three on 18 June 1968, one to four from 20 to 24 June 1967, and one on 23 June 1971. White-rumped Sandpipers were also uncommon in the autumn. An adult banded on 10 August 1967 remained until 19 August. Other autumn records included unaged single birds on 24 July 1971, 1 August 1971, 11 August 1970, 17 August 1969, an adult on 5 August 1969, and

three birds on 30 September 1967. Snyder (1931) saw four White-rumped Sandpipers on 18 June 1927 and reports an observation of two others seen 31 May 1908. Hussell et al. (1966) report one on 29 May 1964 and Hussell et al. (1967) record two on 15 August 1965.

WESTERN SANDPIPER. *Calidris mauri*. Like Weir and Cooke (1976) we were aware of the difficulty of identifying Western Sandpipers in eastern Canada (Ouellet et al. 1973). Russet-colored dorsal plumage and substantially longer and down-curved bills make us confident of the following sightings. A single bird seen on 12 and 13 June 1971 is, to our knowledge, the first spring record for Long Point. During the autumn of 1967, one or two birds were seen from 25 to 27 August, five on 9 September and one on 14 September. During 1969, an adult bird on 8 August and an immature on 20 August were recorded. One adult was seen on 31 July and 1 August 1970 and a bird of unknown age on 13 July 1971. Snyder (1928) reports an adult female collected on 11 July 1927 and Hussell et al. (1967) report one bird on 4 September 1965.

STILT SANDPIPER. *Micropalama himantopus*. This species occurred irregularly between 6 July and 11 September. More than two birds were seldom seen in a day, but on 5 August 1967 five birds were feeding on beach pools. Adults were seen between 6 July and 5 August, immatures between 2 August and 11 September. Snyder (1931) reports that two adults were collected at Long Point on 16 July 1907.

BUFF-BREASTED SANDPIPER. *Tryngites subruficollis*. This species was seen on three occasions: an immature banded on 21 August 1966, another immature on 31 August and 1 September 1969, and a bird of unknown age on 13 September 1968. Hussell (1965) reports one on 19 August 1962.

MARBLED GODWIT. *Limosa fedoa*. One was seen 18 km west of the tip of Long Point on 16 September 1970.

HUDSONIAN GODWIT. *Limosa haemastica*. One Hudsonian Godwit, banded on 25 September 1966, was subsequently seen until 2 October. Cottle (1859) and Saunders (1926) record single specimens collected at Long Point and Hussell (1965) reports three on 17 September and five on 18 September 1963.

AMERICAN AVOCET. *Recurvirostra americana*. Single birds lacking the orange-brown head coloring of breeding adults were seen on 16 October 1967 and 7 September 1968. This species had not previously been recorded at Long Point.

RED PHALAROPE. *Phalaropus fulicarius*. The following numbers of Red Phalaropes were seen inshore

during stormy weather: one on 16 October 1966, two on 20 October 1966, three on 21 October 1967, two on 27 October 1967, and one to 10 from 16 to 19 November 1970. Hussell (1965) reports earlier fall records of 22 and 23 September 1962 and 2 October 1963. On the night of 29-30 September 1965, one was killed at the lighthouse (Hussell et al. 1967).

WILSON'S PHALAROPE. *Steganopus tricolor*. The only Long Point record for this species is one bird on 31 July 1967.

NORTHERN PHALAROPE. *Lobipes lobatus*. One bird was banded on 4 June 1968. Fall records have been reported by Hussell (1965), one on 15-16 September 1963; and Hussell et al. (1966), two on 5-7 October 1964.

Habitat Preference

The number of a species using beach pool habitat, expressed as a percentage of the total number observed of that species, represents its preference for pool habitat. The percentage of observations on beach interface habitat is effectively 100% minus the percentage observed on beach pools, since no significant use of other types of habitat was observed. Because the quantity of habitat count data in the spring of 1971 was small, they are excluded from Figure 3. Habitat preferences were not calculated for periods when fewer than 10 observations of individuals of a species were made.

In 1967 and 1969 all shorebirds, except the Killdeer in 1967 and dowitchers in 1969, fed primarily along the beach interface in spring (Figure 3). The cold water in the beach pools and cool air temperatures (Table 1) probably resulted in meagre amounts of shorebird food in the pools at this time.

Although Black-bellied Plovers, Ruddy Turnstones, Spotted Sandpipers, and Sanderlings preferred the beach interface as feeding habitat during July and August in 1967 and 1969, most species preferred the beach pools (Figure 3). Pool conditions at this time presumably sustained an abundant invertebrate food supply that shorebirds used; the pools were rarely flushed during this period (Table 3) and when they were, high air and lake temperatures (Table 1) probably helped to restore exploitable food resources quickly. Figure 3 shows that most species that fed primarily on beach pools in 1967 and 1969 fed more along the beach interface as

the season progressed. For those species in which a large proportion of the autumn migrants occurred during the July-August period and in which both adults and immatures were observed, we did not observe age-class differences in the use of beach pool habitat. Therefore, although immature birds of most species occurred later in the autumn than did adults, we do not believe that the general decline in use of beach pool habitat through the autumn was due mainly to less efficient use of the beach pools by young birds. Since wind conditions in September and October were such that beach pools were probably flushed more frequently during autumn than in spring or summer (Table 3) we believe that this, combined with cool air and lake temperatures (Table 1), probably had a negative effect on feeding conditions at the beach pools for both age-classes.

Use of beach pool habitat declined in all species except dowitchers from 1967 to 1971 (Figure 3). This decline was likely due to the deteriorating quality of pools as feeding habitat. In 1966 and 1967, beach pools in three areas on the south beach (Figure 1) were separated from the lake by up to 180 m of beach, and were rarely flushed by waves from the lake. By 1969, with the mean water level of Lake Erie up 0.5 m from 1966 (Table 2), one beach pool had disappeared entirely and the remaining two pools were occasionally flushed. By 1970 both remaining pools were continuously open to the lake and by 1971 only temporary pools on the upper beach remained on the south shore. Since beach pools were more numerous and, almost certainly, of better quality as feeding habitat for shore birds in 1967 than in later years of the study, the habitat preference data from 1967 probably better reflect the actual preferences of various species for beach pool habitat than the data from 1969 or 1971. We ranked shorebirds by their preference for beach pool habitat in 1967 (Table 4) and found that migrant species divided into two groups: one group preferred beach pools as feeding habitat and the other preferred the beach-lake interface.

Annual Variation in Abundance

We compared the abundance of shorebirds at Long Point during the period 1 July to 31

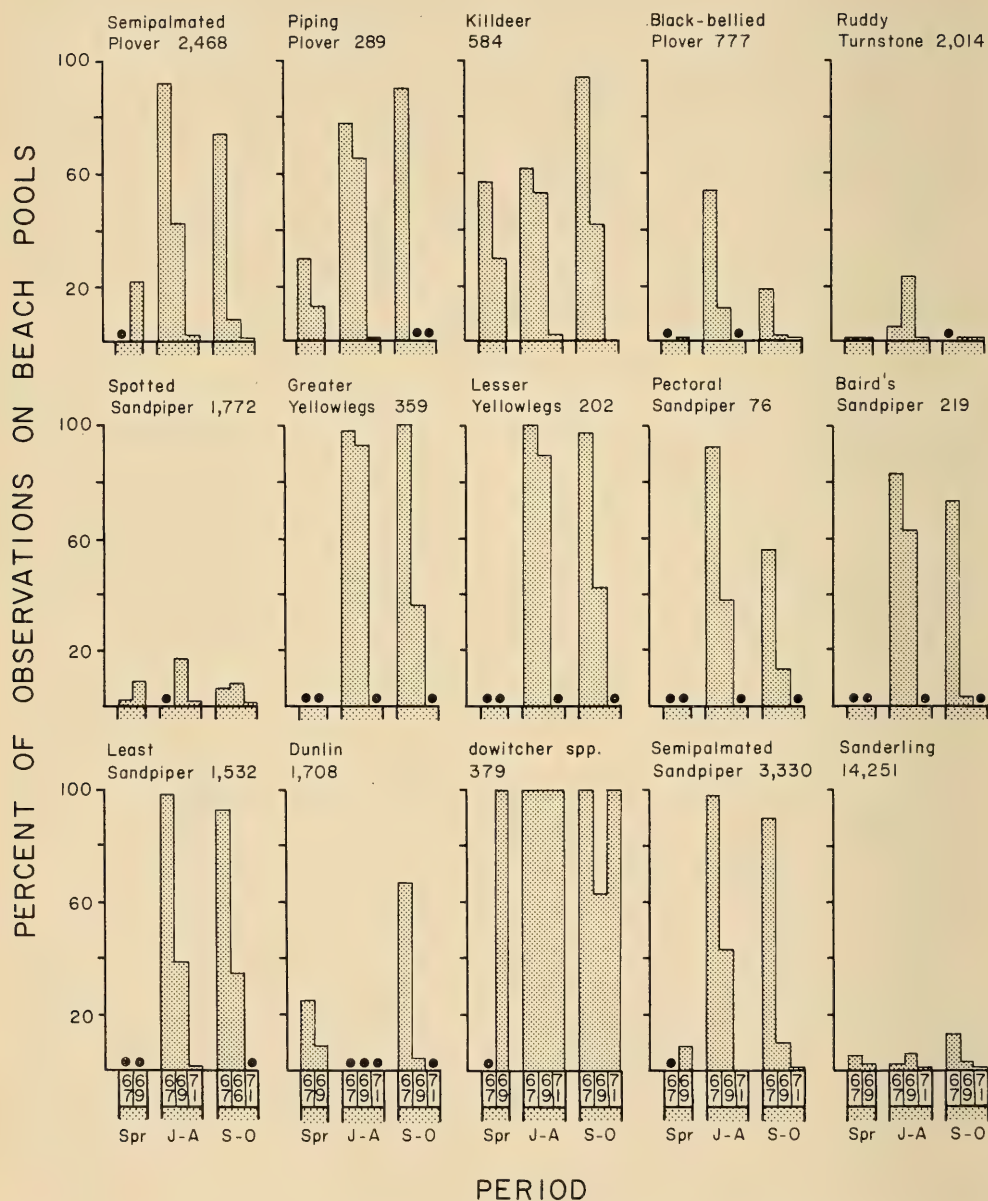


FIGURE 3. Preference of shorebirds for beach pool habitat in 1967, 1969, and 1971. Data are presented for the spring (1 April to 30 June), July-August, and September-October periods. Solid circles above the abscissa indicate fewer than 10 observations of individuals of a species in a period. The number following a species name is the number of individuals on which the habitat analysis is based.

TABLE 4—Variation in the July to October abundance of shorebirds at Long Point and the northeastern Lake Erie shoreline between 1967 and 1971

Species	% on beach pools Jul. - Oct. 1967 ¹	Long Point		Northeastern Lake Erie			
		Mean \pm S.E. (N) ² per census per 5-day period		Test statistic ³	Mean \pm S.E. (N) ⁴ per census		Test statistic ³
		1967	1971		1967	1971	
Nesting species							
Piping Plover		2.3 \pm 2.2 (18)	0.4 \pm 0.9 (17)	46.5 ***	—	170.3 \pm 38.8 (4)	2.0 n.s.
Killdeer		3.8 \pm 1.8 (8)	4.4 \pm 2.7 (13)	44.5 n.s.		131.3 \pm 10.5 (4)	4.0 n.s.
Spotted Sandpiper		7.6 \pm 16.4 (14)	18.1 \pm 10.9 (16)	18.5 ***			
Beach pool species							
Dowitcher spp.	100	3.0 \pm 1.9 (16)	0.8 \pm 2.1 (10)	18.0 ***		22.0 \pm 3.5 (3)	19.0 \pm 11.6 (4)
Greater Yellowlegs	99	1.7 \pm 1.5 (23)	0.1 \pm 0.4 (16)	4.5 ***		9.3 \pm 2.3 (3)	41.3 \pm 39.3 (4)
Lesser Yellowlegs	99	3.9 \pm 4.1 (19)	1.0 \pm 0.7 (11)	59.0 ***		95.3 \pm 26.2 (3)	72.5 \pm 13.4 (4)
Least Sandpiper	96	18.2 \pm 9.9 (17)	1.6 \pm 1.4 (14)	6.5 ***		116.3 \pm 62.5 (3)	102.8 \pm 39.7 (4)
Semipalmated Sandpiper	94	21.2 \pm 17.5 (20)	6.0 \pm 5.5 (15)	2.5 ***		535.3 \pm 291.7 (3)	398.0 \pm 38.3 (4)
Semipalmated Plover	83	11.2 \pm 9.5 (22)	4.1 \pm 4.3 (16)	2.5 ***		75.0 \pm 34.8 (3)	67.5 \pm 15.0 (4)
Baird's Sandpiper	78	2.8 \pm 2.9 (14)	0.4 \pm 0.4 (12)	42.0 **		0.3 \pm 0.6 (3)	0.8 \pm 0.5 (4)
Pectoral Sandpiper	77	0.7 \pm 1.0 (18)	0.2 \pm 0.7 (14)	84.5 n.s.		26.3 \pm 4.4 (3)	12.8 \pm 4.7 (4)
Beach interface species							
Black-bellied Plover	37	1.4 \pm 1.5 (24)	4.2 \pm 9.9 (16)	0.2 n.s.		5.0 \pm 5.0 (3)	12.8 \pm 5.8 (4)
Dunlin	34	7.9 \pm 7.5 (13)	3.1 \pm 5.8 (6)	19.5 n.s.	—	—	—
Sanderling	8	24.9 \pm 17.3 (23)	59.3 \pm 32.5 (22)	3.6 ***		73.3 \pm 43.1 (3)	77.5 \pm 17.3 (4)
Ruddy Turnstone	3	1.2 \pm 1.3 (13)	2.1 \pm 1.9 (11)	43.5 n.s.		13.0 \pm 11.5 (3)	21.5 \pm 13.3 (4)

¹ Average of the July-August and September-October values from Figure 3.² N = number of inclusive 5-day periods between the first and last sightings of each species.³ Test statistic = Mann-Whitney U when N for both 1967 and 1971 \leq 20; when either N \geq 20, test statistics = |z|.Two-tailed probabilities as follows: n.s. = not significant; * = marginally significant (0.05 $<$ P \leq 0.1); ** = significant (0.01 $<$ P \leq 0.05); *** = highly significant (P \leq 0.01).⁴ N = number of censuses.

October in 1967 and in 1971. Since Page and Bradstreet (1968) have shown that marked Least and Semi-palmated Sandpipers may remain on Long Point for many days during migration, daily census data are not statistically independent for these and probably other species. To improve independence and minimize the skewness that consideration of 5-day peak counts would cause, the mean number of birds seen per count in each 5-day interval was used as the unit of observation in comparison of the 1967 and 1971 data. The sample size in each year was the inclusive number of 5-day intervals between the first and last sightings of a species.

The Buffalo Ornithological Society counted shorebirds in two areas totalling approximately 32 km of northeastern Lake Erie shoreline in 1967 and 1971 (Seeber 1967; A. R. Clark, unpublished data) (Figure 1). Three counts were made in 1967 (22–23 July, 18–19 August, and 2–3 September) and four in 1971 (18 July, 8 and 22 August, and 5 September). The mean number of shorebirds per count is used to compare the abundance of the birds between the two years. For comparisons between years in both areas, Mann-Whitney U tests (Siegel 1956) are used. Variations in shorebird abundance in 1967 and 1971 are then compared between Long Point and northeastern Lake Erie.

Nesting Species. Mean numbers of Killdeer at Long Point did not differ significantly between 1967 and 1971 ($P>0.1$). Significantly fewer ($P<0.01$) Piping Plovers were seen in 1971 than in 1967. Snyder (1931) estimated 100 nesting pairs of Piping Plovers at Long Point in 1927 and 1928, and Hussell and Montgomerie (1968) about seven pairs between 1961 and 1965. By 1971, only four adult Piping Plovers were present and to our knowledge only one young was fledged. Significantly more ($P<0.01$) Spotted Sandpipers were seen in 1971 than in 1967.

Beach Pool Species. All eight species that fed primarily at beach pools during the southbound migration in 1967 were less abundant in 1971 (Table 4). This decline was highly significant ($P<0.01$) for Greater Yellowlegs, Least Sandpipers, and dowitchers, significant ($P<0.05$) for Semipalmated Plovers, Baird's and Semipalmated Sandpipers, marginally significant ($0.1>P>0.05$) for Lesser Yellowlegs, and not

significant ($P>0.1$) for Pectoral Sandpipers. Considering all eight species combined, only 23% as many individuals were seen on an average census in 1971 as in 1967. In contrast, 81% as many were seen in 1971 as in 1967 along the northeastern shoreline of Lake Erie.

Beach Interface Species. For species that fed primarily along the beach-lake interface at Long Point, no significant changes were found in autumn numbers of Black-bellied Plovers, Ruddy Turnstones, or Dunlins (Table 4). The increase in the numbers of Sanderlings between 1967 and 1971, however, was highly significant ($P<0.01$) (Table 4).

Discussion

Shorebirds generally arrive earlier in the autumn at Long Point than at Kingston and with the exception of the Sanderling remain later at Kingston than at Long Point (cf. Weir and Cooke 1976). The exception of the Sanderling is probably related to its much greater abundance at Long Point as compared to Kingston. Coverage at Kingston was probably not as intense as at Long Point in July and *vice versa* late in the fall. Also beach pool habitat deteriorates at Long Point as the season progresses, probably in contrast to some areas such as the sewage ponds which were censused at Kingston.

Data on differential age migration at Long Point are generally more complete than the Kingston data for species which both studies cover. At Long Point, immature Semipalmated Plovers were observed about two weeks earlier in the autumn than at Kingston. Weir and Cooke (1976) found adult and immature Black-bellied Plovers at Kingston in October but at Long Point, we found only immatures. Weir and Cooke imply that Pectoral Sandpipers seen at Kingston in October were small females, but we found that at Long Point birds caught in September and October were immatures and not attributable to either sex.

If breeding success or mortality in 1967 was markedly different than in 1971, either factor could account for the significant decline in shorebird abundance noted at Long Point but shorebird populations at nearby localities should have been similarly affected. There were, however, no significant differences in the num-

bers of each species counted along the north-eastern shoreline of Lake Erie in 1967 and 1971 (Table 4), although the number of counts was small. Hence it seems unlikely that variable breeding success or mortality account for the differences noted at Long Point. We believe that the rising water level of Lake Erie was the most important factor causing the decline. As the lake level rose and the quality of beach pool habitat deteriorated, six of eight species that preferred to feed on beach pools declined significantly. The rising lake level did not reduce the amount of beach interface and none of the species favoring it as feeding habitat declined significantly. In fact, Sanderlings increased in numbers between 1967 and 1971.

Beach pools do not occur along the north-eastern shoreline of Lake Erie and shorebirds in this area feed on mats of algae and decaying vegetation along the interface (Seeber 1966; personal observations). Rising water levels did not affect the availability of this feeding habitat and no significant changes were found in the number of shorebirds using this area. Rising lake levels should not affect the size of the breeding populations of either Killdeer or Spotted Sandpipers at Long Point as few of either species nest on the south beach; their numbers did not decline during the study. The reasons for the significant increase in the numbers of Spotted Sandpipers from 1967 to 1971 are unclear at this time but may, in part, be due to sampling design. Piping Plovers, on the other hand, require a wide and relatively undisturbed beach for nesting (Wilcox 1959). As the water level of Lake Erie rose, a simultaneous reduction in the width of Long Point's south beach occurred. Since Piping Plovers nest only on the south beach, rising lake levels, by reducing the beach width between 1967 and 1971, may have been partly responsible for the decline in numbers of Piping Plovers.

At least two shorebird species are somewhat traditional in their use of Long Point during the southbound migration. One percent of 731 Semipalmated Sandpipers and 7% of 471 Sanderlings banded between 1966 and 1970 were recaptured at Long Point in years subsequent to banding.

The loss or deterioration of feeding habitat at a traditional staging area probably has detri-

mental effects on migrant shorebirds. Those birds capable of shifting to nearby staging localities may do so. Those birds incapable of shifting to a nearby locality or for which a suitable alternative does not exist would be expected to be less fit to continue migration than birds using better quality habitat.

While an increase in Lake Erie water levels was observed to result in the decline, at Long Point, of numbers of shorebirds that preferred beach pools as feeding habitat, the increase resulted as part of a natural cycle in Great Lakes water levels (Laidly 1962) and the number of birds involved was very small. In certain areas of James Bay and the Maritimes where large-scale alterations of the environment are proposed, however, very large numbers of shorebirds build up fat reserves for long, non-stop flights (Hope and Shortt 1944; McNeil and Cadieux 1972; McNeil and Burton 1973). If some shorebird populations are rigid in their use of such major staging areas, and if no alternative sites exist, the destruction of those areas could destroy the populations involved. If, on the other hand, shorebirds can shift staging localities, it is important to know to what extent this may be possible, what species are behaviorally able to do so, and whether alternative areas may be capable of supporting the displaced population. More research along such lines is necessary.

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Population Dynamics, Home Ranges, and Habitat Associations of the Yellow-cheeked Vole, *Microtus xanthognathus*, in the Northwest Territories

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Abstract. Demographic features of Yellow-cheeked Vole, *Microtus xanthognathus*, populations were examined on two live-trapping grids near Chick Lake, Northwest Territories. Populations on the two grids were probably out of phase with each other. Most demographic features were similar to those described for other species of *Microtus*. Home range sizes were variable. Sizes were from 116 m² to 27 500 m² and average lengths of ranges were from 15 m to 255 m. Sizes of home ranges were similar to those recorded for smaller species. Habitat data suggest broad ecological amplitude but voles occurred continuously only in dense stands of Black Spruce (*Picea mariana*). Micro-habitat analysis indicated association with only a few plant species and captures were associated with micro-topography.

A controversy over interpretation of Pleistocene environments using fossil remains of *Microtus xanthognathus* as indicators is discussed. Habitat selection data suggest that some interpretations may be too restrictive.

Key Words: *Microtus xanthognathus*, population, habitat, home range, Northwest Territories.

The Yellow-cheeked Vole, *Microtus xanthognathus*, is a medium-sized microtine rodent distributed throughout the boreal forest of northwestern Canada. Little is known about its ecology, and most ecological information for this species has been contained in distribution records (Osgood and Bishop 1900; Osgood 1909; Rand 1945; Lensink 1954; Youngman 1975). These papers contain only subjective descriptions of populations and habitat selection. This paper presents data for Yellow-cheeked Voles obtained from an extensive live-trapping program conducted in the boreal forest in the Northwest Territories during 1973, 1974, and 1975.

A secondary purpose in presenting these data stems from controversy over interpretation of Pleistocene environments using fossil remains of Yellow-cheeked Voles as indicators. Hallberg et al. (1974) questioned Guilday's (1971) interpretation of cave remains as being from strictly taiga (essentially the ecotone between the boreal forest and tundra) associations, based on the presence of Yellow-cheeked Vole remains, since other mammal remains found in the same strata were considered to be more closely associated with southern boreal conditions. Data presented here on habitat selection of Yellow-cheeked Voles in the boreal forest may help clarify

confusion over interpretations of Pleistocene environments.

The objectives of the field work in this study were (1) to quantify demographic features of populations of Yellow-cheeked Voles and to compare these to similar parameters reported for other microtine rodents, (2) to describe sizes of home ranges of this species, and (3) to collect data concerning habitat and micro-habitat selection as inferred from live-trapping data.

Methods

This study was conducted in the northern boreal forest near Chick Lake, Northwest Territories. Chick Lake (65°52' N, 128°07' W), located west of the Mackenzie River between Norman Wells and Fort Good Hope, is approximately 70 km south of the Arctic Circle and is at an elevation of 120 m above mean sea-level. A full description of the general area surrounding Chick Lake can be found in Gubbe and Janz (1974).

Sampling was conducted on two live-trapping grids and 13 live-trapping transects. Figure 1 shows the locations of sampling sites near Chick Lake. Data from trapping grids were used to describe demographic features of Yellow-cheeked Vole populations, home range sizes, and micro-habitat selection. Data from transects

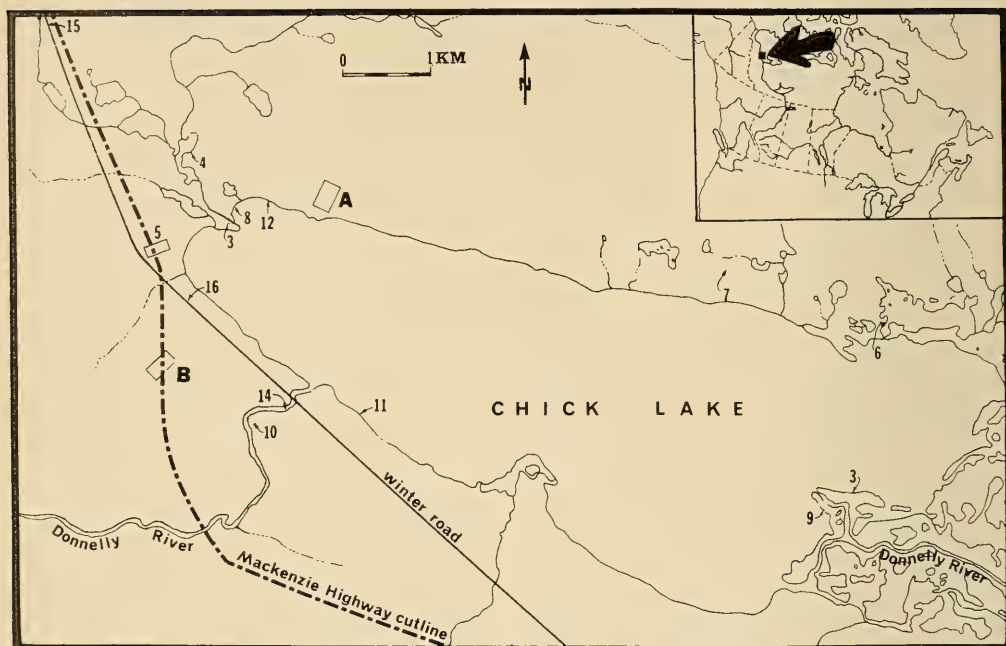


FIGURE 1. Map of the study area showing the locations of trapping grids and transects. Numbers indicate the locations of the following sampling sites: 3, Creek bank; 4, small lakeshore; 5, burn; 6, birch forest; 7, open spruce; 8, shore of Chick Lake; 9, willow bar; 10, hillside; 11, Alder-covered lakeshore; 12, forested lakeshore; 13, White Spruce forest; 14, river bank; 15, hilltop; 16, Black Spruce forest.

were used to describe distribution of Yellow-cheeked Voles in relation to general habitat types occurring in the study area. Data collected by McDonald (1974) in "a burned over" area near Chick Lake are also included in the habitat discussion.

The two live-trapping grids were constructed on opposite sides of Chick Lake. Each grid consisted of 250 stations with one trap at each, marked with surveyor's stakes spaced at 15-m intervals. The grids were 10 columns wide by 25 rows long and encompassed areas of 4.86 ha each. Sampling was conducted during July through October 1973, June through October 1974, and during June, August, and September 1975. The grids were trapped for the first 10 days of each month during 1973 and 1974 except October, which was sampled for 7 days, and during the first 7 days of each month during 1975.

One hundred traps were placed on each transect at 8-m intervals and were arranged in

either a grid or line. Traps were set on each transect for 3 days each month.

Sherman live-traps, $23 \times 8 \times 9$ cm, were used on both grids and transects during all but the first month of the study. During the first month, home-made can traps were used. Traps were baited with rolled oats, covered with moss, and checked twice daily.

Each animal was individually numbered by toe-clipping and was released at the point of capture. The number, location of capture, sex, breeding condition, and weight were recorded for each animal every time it was captured.

Quadrats (one per trap station) of 1 m^2 were used to determine frequency of occurrence and percentage cover for all plant species on both grids. Coverage values were classified according to a scheme described by Daubenmire (1959). The degree of micro-relief or micro-topography within a 2-m radius of each trapping station was classified according to the following designations: class 0, ground flat; class 1, small

hummocks up to 15 cm tall; class 2, tall hummocks >15 <30 cm tall; class 3, undercut and collapsing hummocks >30 cm and <50 cm tall; class 4, areas with hummocks >50 cm tall.

Results and Discussion

Population

The Yellow-cheeked Vole comprised only a small portion of the small mammal community as indicated by live-trapping in the Chick Lake area. In 102300 trap-nights (TN) of effort, nine species of small mammals were captured. These were Northern Red-backed Voles (*Clethrionomys rutilus*), 10319 captures of 2345 individuals; Yellow-cheeked Voles (*Microtus xanthognathus*) 937 captures of 360 individuals; Meadow Voles (*M. pennsylvanicus*), 863 captures of 479 individuals; Masked Shrew (*Sorex cinereus*), 30 captures of 30 individuals; Northern Bog Lemming (*Synaptomys borealis*), 25 captures of 23 individuals; Heather Vole (*Phenacomys intermedius*), 15 captures of 8 individuals; Red Squirrel (*Tamiasciurus hudsonicus*), 12 captures of 10 individuals; Ermine (*Mustela erminea*), 3 captures of 3 individuals; and Meadow Jumping Mouse (*Zapus hudsonius*), 1 capture of 1 individual.

No previous studies have described the demographic features of Yellow-cheeked Vole populations. Any mention of population size in taxonomic reports have not been quantitative, although apparently Yellow-cheeked Voles can be fairly numerous and fluctuate in number. Rand (1945) suggested that these voles were subject to violent population fluctuations. Lensink (1954) interviewed fur trappers who indicated that the voles were numerous, and natives at Old Crow in the Yukon Territory said that these voles exploded in numbers about every 20 years (Youngman 1975).

In this study, sizes of populations of Yellow-cheeked Voles are represented by three measures: minimum number of individuals known to be present per grid per month, the number of individuals per hectare per month (number present/area of grid), and the number of captures per 100 TN per month (Figure 2). Minimum densities were less than 1/ha and maximums were near 10/ha. As recommended by Krebs (1966) no attempt was made to estimate population density by capture-recap-

ture techniques because of non-random sampling.

A sharp decrease in the population occurred on Grid B between July and August 1973 and was almost entirely the result of trap mortality. Yellow-cheeked Voles were too large for the home-made can traps and many were killed by the closing doors of traps. No animals were directly killed by traps after the can traps were replaced by Sherman traps. A sharp decrease in numbers on both grids, which occurred between September and October 1974, may have been the result of inhibited activity in October caused by snow depths of 30 cm and temperatures of -33°C . Even though weather conditions were not as severe during October 1973, population indices for October of both years are not considered as accurate as they may have been during other months.

Yellow-cheeked Vole populations on the two grids appeared to be out of phase with each other in their yearly fluctuations. The population on Grid A went through two summers (1973, 1974) of relatively low numbers, increasing slightly over winter between these summers and then increased over the 1974–1975 winter, thus entering an apparent increase phase with larger numbers occurring during 1975. The population on Grid B was in a high or increase phase when the study began in 1973, was accidentally reduced, increased over winter, and reached a peak phase in 1974 followed by a decrease that lasted through the winter with the population remaining very low through 1975. Essentially populations on the two grids were fluctuating in opposite fashion.

Two patterns of population fluctuation were observed, seasonal and multi-annual. Within each of the multi-annual population fluctuations there was a seasonal change that occurred on both grids. Populations were generally small early in the year, increased through the summer, and began to decline as fall approached. Thus while the seasonal fluctuations were similar on the two grids, the multi-annual fluctuations were asynchronous. Krebs and Myers (1974) describe the "demographic machinery" which can cause fluctuations as being comprised of reproduction, mortality, and dispersal. Some data concerning each of these were collected for Yellow-cheeked Voles at Chick Lake.

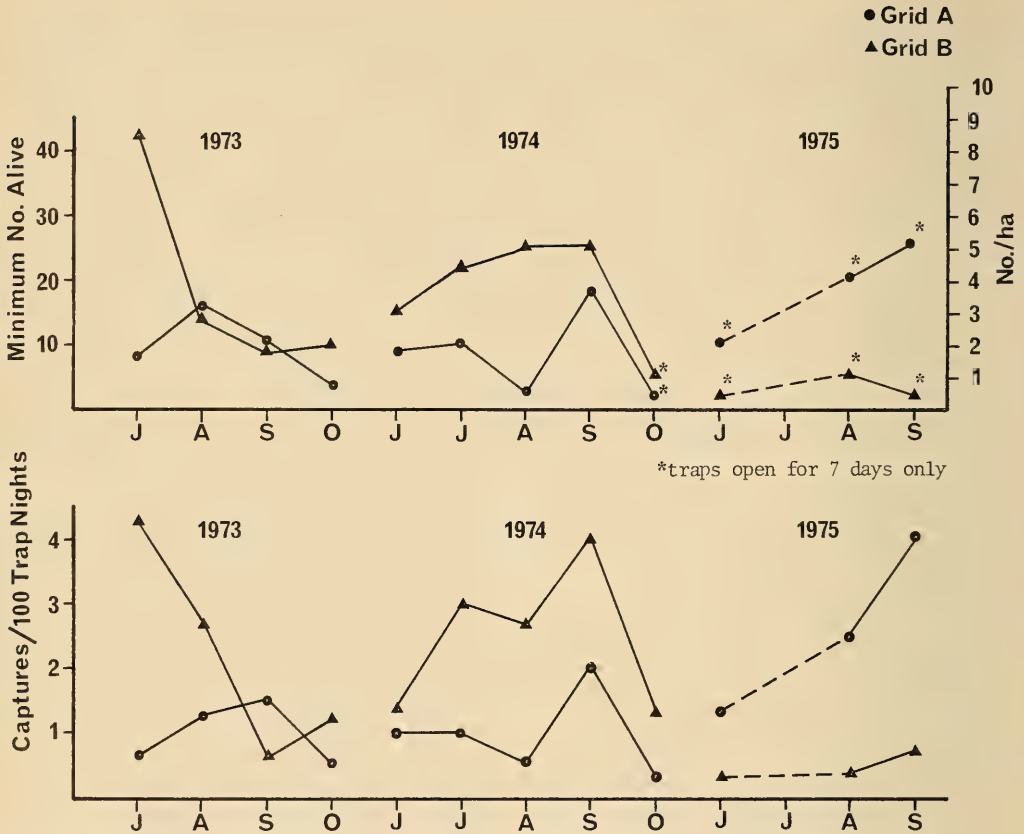


FIGURE 2. Population sizes of Yellow-cheeked Voles on two trapping grids near Chick Lake, Northwest Territories, represented by the number of individuals captured and the number of captures per 100 trap nights.

As first described for *M. agrestis* by Chitty (1952) large individuals occur more often in high populations than in low populations. A similar situation is evident for Yellow-cheeked Voles as indicated by the distribution of live weights of males (Figure 3). Voles weighing 90 g or more were trapped only during high population densities on each grid, which is consistent with the general microtine population syndrome.

Reproduction

Data concerning pregnancy rates, percentage of animals in breeding condition, length of breeding season, and sex ratios were collected for Yellow-cheeked Voles. Figure 4 shows the percentage of female Yellow-cheeked Voles that

were apparently pregnant, and the percentage of adults in breeding condition (vulva swollen or vaginal membrane absent for females; testes in scrotal position for males). The sample was not sufficient to permit a meaningful assessment of trends, but there was no indication of increased pregnancy rates preceeding or accompanying the population increases or peaks demonstrated by Yellow-cheeked Voles. The sample size was again too small to show any association between percent in breeding condition and population sizes or increases. Although sample sizes are small, the indication from the data that neither pregnancy nor breeding rates increased with or prior to population increases is consistent with changes in similar parameters described for

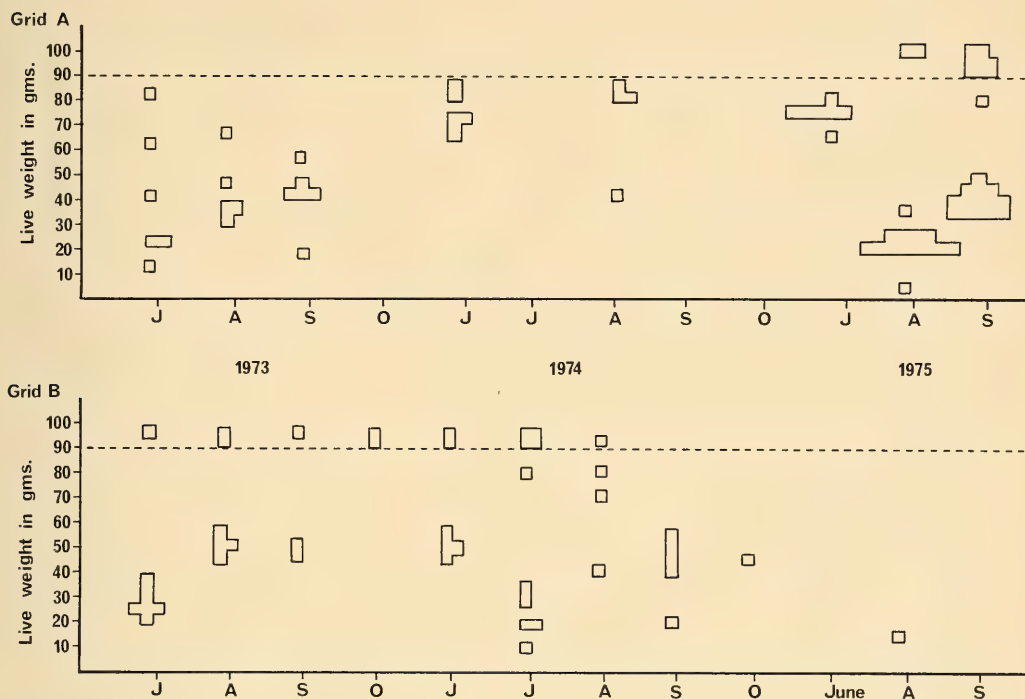


FIGURE 3. Live weights of male Yellow-cheeked Voles on two trapping grids near Chick Lake, Northwest Territories. Each square represents the weight of one vole.

other microtine rodents as discussed by Krebs and Myers (1974).

Since sampling did not begin until June during each season the onset of breeding can only be inferred from the date the first apparently juvenile voles (less than 30 g) appeared. Voles this size were not captured before July, suggesting that breeding occurred in May (Figure 3). The end of the breeding season, however, occurred by October on both grids during 1973 and 1974 (Figure 4). If this is an accurate assessment, there is no indication that the breeding season was longer during the possible increase or peak phases that occurred on Grid B during 1973 and 1974 or on Grid A during 1975. Other microtines generally have increased lengths of breeding seasons prior to peak phases (Krebs and Myers 1974).

Changes in sex ratios of microtines have not been found to be associated in any consistent

way with population fluctuation (Krebs and Myers 1974). Sex ratios were calculated for Yellow-cheeked Voles on both grids for each trapping season. The male to female ratios were as follows:

	1973	1974	1975
Grid A	20:28	24:24	34:29
Grid B	29:58	34:72	1:7

The ratios appear to have been associated more with a particular grid than with population density. Ratios on Grid A were close to 50:50 and those on Grid B favored females. As described for other microtines, changes in sex ratio did not appear to be associated with population fluctuations.

Mortality and Dispersal

The inverse of mortality, survival, will be considered since there was no way of knowing

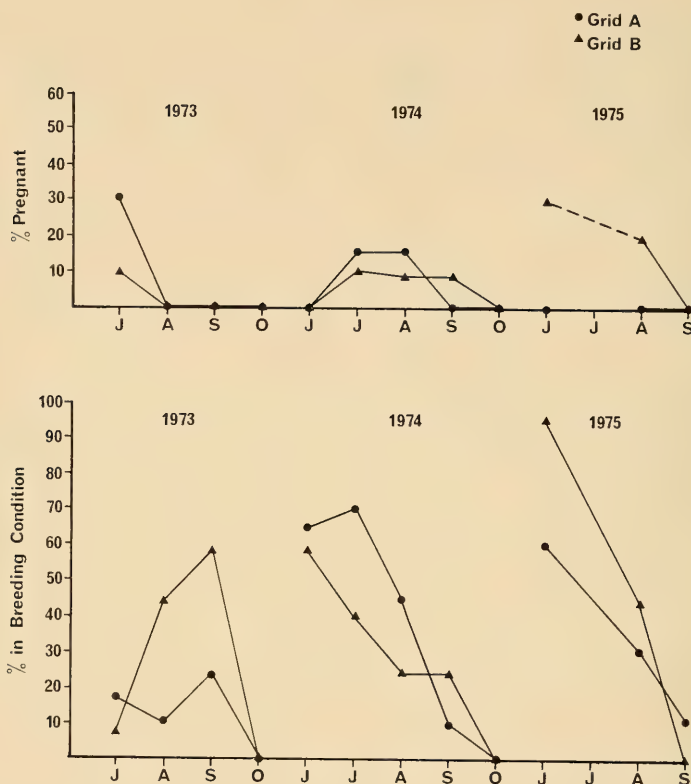


FIGURE 4. Breeding status of Yellow-cheeked Vole populations on two trapping grids near Chick Lake, Northwest Territories.

whether voles died *in situ* or emigrated when they ceased being captured on the grids. Figure 5 shows the survival rates of voles on both grids. Survival on Grid A was moderate to low during low population phases 1973 and 1974 but was high during the increase phase, 1975. Grid B population survival rates were somewhat higher than those on Grid A during 1973 and 1974, during high or increased population phases on Grid B, but went to zero during the low phase in 1975. Survival was high in populations that were in an increase or peak phase and was low during phases of low population densities. Krebs and Myers (1974) described similar phenomena for other microtines.

Only anecdotal information is available concerning dispersal of Yellow-cheeked Voles. In this study, voles were captured in more

different habitats, i.e., Black Spruce (*Picea mariana*) forest, small lakeshore, alder (*Alnus crispa*)-covered lakeshore and the river bank on the south side of Chick Lake during 1973 (Table 1) when populations were higher on that side of the lake, as indicated by populations on Grid B, than during 1974 or 1975. Also, Yellow-cheeked Voles were captured in an additional habitat, open spruce, as well as the dense Black Spruce forest on the north side of the lake during 1975 when populations were increasing on that side as indicated by populations on Grid A. If the occurrence in several habitats can be considered to be indicative of dispersal, the dispersal during high population densities, and particularly increasing densities, coincides with dispersal phenomena described in the population syndrome of Krebs and Myers (1974).

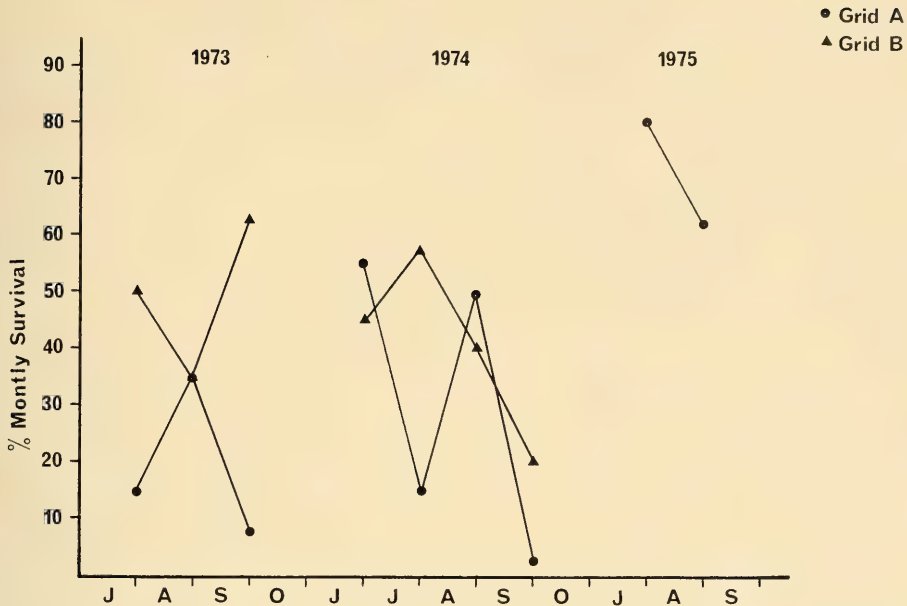


FIGURE 5. Monthly survival rates for Yellow-cheeked Voles on two trapping grids near Chick Lake, Northwest Territories. Survival is expressed as the percentage of voles recaptured during month T + 1 that were originally captured during month T.

Home Range

Sizes of home ranges were calculated using the convex polygon index (Jenerich and Turner 1969) for each Yellow-cheeked Vole captured three or more times. The maximum lengths of home ranges were also calculated by measuring the distance between the two most distant capture points for each individual captured three or more times. Home ranges were not calculable when the only three capture points formed a line. Maximum lengths of home range were calculated for these, however. During the three summers a total of 29 home range sizes and 42 lengths of home ranges were calculated for Yellow-cheeked Voles.

Table 2 shows the average sizes and lengths of home ranges according to grid, year, and sex. Sample sizes were insufficient to make any conclusions from number of captures and home range size for this species. Average measurements of both parameters were extremely variable. Average home ranges varied from 116 m² for males on Grid A during 1973 to 2671 m² for females on Grid B during 1974. The

smallest average maximum length of home range was 25 m for males on Grid A during 1973 and the largest was 181 m for females on Grid B during 1973.

The only other home range sizes previously reported for Yellow-cheeked Voles were for two individuals found near San Sault rapids in the Northwest Territories (Mitchell 1973). The home ranges were 769 m² for a male and 405 m² for a female, both of which fall within the ranges of those measured at Chick Lake. Yellow-cheeked Voles also had home ranges similar in size to those previously recorded for the smaller Meadow Vole. Some of the recorded home ranges of Meadow Voles are 232 m² (Hamilton 1937); 809 m² to 2023 m² (Blair 1950); and 267 m² to 2023 m² (Hayne 1950); and 232 m² to 8829 m² at Chick Lake (Douglass 1975). Apparently the relatively large Yellow-cheeked Vole does not require home ranges larger than those normally required by smaller voles.

Habitat Associations

Habitat selection was inferred from associa-

TABLE 1—Description of live-trapping sites near Chick Lake, Northwest Territories, TN = trap nights

Title	Topography	Dominant vegetation	Captures/100 TN		
			1973	1974	1975
Sites associated with "edges"					
Creek bank	Thermally and hydrologically eroded, very steep, broken	Black Spruce, lichens, moss	0.0	0.0	0.0
Small lakeshore	Gently sloping, flat	Sedges, willows	0.1	0.0	0.0
Shore of Chick Lake	Gently sloping, flat	Sedges, grasses	0.0	0.0	0.0
Alder-covered lakeshore	Gently sloping	Alders, grasses	0.1 ¹	0.0	0.0
Forested lakeshore	Steeply sloping	Black Spruce, White Spruce, mosses	0.0	0.0	0.0
River bank	Cutbanks of river, boulder covered, steep and slumping	Alders, Black Spruce, sedges	0.1 ¹	0.0	0.0
Sites not associated with "edges"					
Hilltop, Grid A and B	Level and hummocky	Black Spruce, <i>Ledum</i> , sedges, lichens	1.6	1.6	1.1 ³
Black Spruce forest	Gently sloping with small hummocks	Black Spruce, lichens, mosses	0.0	0.0	0.0
Burn*	Gently sloping with large hummocks	Burned in 1969, standing dead trees, bog birch, willows and sedges	0.2	0.0	—
Birch forest	Level to gently sloping	Birch trees, <i>Ledum</i>	0.0	0.0	0.0
Open spruce	Level and flat	Sparse Black Spruce, lichens	0.0	0.0	0.1 ²
Willow bar	Level and flat, river bank	Alders, willows	0.0	0.0	0.0
Hillside	Steep, slumping hillside	Birch trees, alders	0.0	0.0	0.0
White Spruce forest	Level, flat	Mature White Spruce, little understory	0.0	0.0	0.0

*Sampled by McDonald (1975) during 1973 and 1974.

¹Represents single captures made during August 1973.

²Represents single capture made during September 1975.

³Captures occurred at these locations during every sampling period.

tion of vole captures with general habitat type and micro-habitat as represented by individual plant species and micro-topography. It was assumed that habitats in which captures of Yellow-cheeked Voles occurred were more suitable for the voles than those habitats without captures.

Table 1 lists the sites that were sampled, gives a general description of each, and average captures per 100 TN for each. More detailed information can be found in Douglass (1975). Of the 16 sites sampled, Yellow-cheeked Voles were captured in only eight: Grids A and B plus the hilltop, burn, open spruce, small lakeshore, alder-covered lakeshore, and river bank transects. Yellow-cheeked Voles were captured all three years only in non-edge habitats dominated

by Black Spruce (both grids and the hilltop transect). The failure to capture Yellow-cheeked Voles in a fourth Black Spruce habitat (Black Spruce forest, Table 1) indicates that the Black Spruce forest was sufficient for continuous occupation but was not necessarily always occupied.

Captures were not made during every sampling period in most habitats (Table 1). It is hypothesized that these habitats were marginal, being occupied by transients, as suggested for Muskrats by Errington (1967) when "optimal" habitats, presumably Black Spruce forests, had peak populations or as the populations in the "optimal" habitats were increasing (Krebs and Myers 1974).

Guilday et al. (1964) reviewed the literature on

TABLE 2—Average sizes (mean \pm 1 SD) of home ranges (m^2) and maximum lengths (m) of range for Yellow-cheeked Voles near Chick Lake, Northwest Territories, during 1973, 1974, and 1975

	1973				1974				1974			
	Grid A	(N)	Grid B	(N)	Grid A	(N)	Grid B	(N)	Grid A	(N)	Grid B	(N)
Size of Home Range												
Males	116	— (1)	522 \pm 487	(2)	754 \pm 1209	(6)	1161 \pm 957	(4)	1433 \pm 1375	(3)	—	(0)
Females	—	(0)	1161	— (1)	929	— (1)	2671 \pm 2698	(6)	2094 \pm 1715	(5)	—	(0)
Maximum Length of Home Range												
Males	25 \pm 3	(2)	37 \pm 30	(5)	133 \pm 41	(4)	44 \pm 50	(4)	82 \pm 37	(3)	—	(0)
Females	29 \pm 13	(2)	181 \pm 97	(2)	58 \pm 40	(2)	59 \pm 43	(9)	73 \pm 49	(6)	—	(0)

Yellow-cheeked Vole habitats and concluded that this species was adapted to a broad range of habitats. Youngman (1975) examined both published and unpublished accounts of Yellow-cheeked Vole habitats and also concluded that this species displayed broad ecological amplitude but found that most records indicated association with recently disturbed areas near mineral soils.

The habitat data from Chick Lake also suggest a broad ecological amplitude in that Yellow-cheeked Voles were captured in several different habitat types. The Chick Lake data indicate, however, that even though Yellow-cheeked Voles could be captured at one time or another in many different habitats, including a recently burned area and river bank with mineral soils, they could be captured consistently only in the Black Spruce forest which was relatively undisturbed and situated on organic soils.

The first step in describing micro-habitat selection was the determination of whether frequency of occurrence of plant species at trapping grid stations where voles were captured was different from the overall frequency of occurrence of all plant species on each grid. A goodness of fit chi-square analysis (Sokal and Rolf 1969) was used to compare expected frequencies at capture points to observed frequencies. For each capture, the vegetation plot recorded for the station where the capture occurred was included as an individual observation in the analysis. All micro-habitat analyses were performed by computer on plant and capture data collected during 1974. A summary of the vegetational characteristics of both grids is shown in Table 3.

The chi-square analysis showed that Yellow-cheeked Vole captures occurred at stations with frequencies of occurrence of all plant species that were significantly different from the frequency of occurrence of all plant species as they occurred on the grid, on Grid A $\Sigma\chi^2 = 73.37$ $df = 37$ $P < 0.05$ but not Grid B $\Sigma\chi^2 = 42.24$ $df = 38$ $P > 0.05$. This suggests that Yellow-cheeked Voles were being selective of areas in which they were captured on Grid A but not Grid B.

The analysis was carried further to determine which individual plant species or locations in which they occurred were selected for or against. Chi-square association tests (Cole 1949) were employed to determine whether there was a

TABLE 3—Summary of soil and vegetational characteristics of Grid A and Grid B at Chick Lake, Northwest Territories

	Grid A	Grid B		
Soil characteristics (mean values) (depth in cm)				
Organic layer	37	19		
Active layer	55	48		
Tree characteristics (mean values)				
Height (m)	4.3	4.3		
DBH (cm)	5.0	3.8		
Density (stems/ha)	6869.0	8714.0		
Plant cover* and number of species				
	% Cover	No. species	% Cover	No. species
Trees	13.4	6	23.1	4
Shrubs	79.2	10	67.0	7
Herbs	27.5	7	22.2	10
Mosses	68.3	6	56.8	6
Lichens	32.4	8	39.1	11
Litter	1.2	—	4.8	—

*See Daubenmire (1959).

relationship between captures of Yellow-cheeked Voles and the occurrence of any particular plant species at capture points. Correlation coefficients were also calculated between the number of captures/100 TN and the percent coverage of each plant species. Table 4 presents the results of these analyses only for those species found to be statistically significantly associated with or correlated with vole captures. Fourteen species and one major group, Gramineae, were found to be associated (significant chi-square association values) with or correlated (significant correlation coefficients) with Yellow-cheeked Vole captures on either or both of the two grids. Captures were determined to be significantly associated with 11 species plus Gramineae, and the number of captures/100 TN showed correlations with cover of three species and Gramineae.

Captures on both grids were associated with the presence of *Vaccinium uliginosum* (nega-

tively), Blueberry; *Picea mariana*, Black Spruce; and captures on both were associated with and correlated with Gramineae. These two species and Gramineae should probably be considered to have been the most important to Yellow-cheeked Voles.

Gramineae, *Calamagrostis canadensis* in particular, was considered as food for Yellow-cheeked Voles by Youngman (1975), and captures were associated with the presence and amount of Gramineae in this study, possibly because the voles were attracted in search of food. Small *P. mariana* less than 2 m tall usually formed very dense cover on the two grids. The association between captures and the occurrence of this species was probably indicative of the use of small *P. mariana* as cover. The negative association between captures and the occurrence of *V. uliginosum* is puzzling since Youngman (1975) found berries from this species in the mouths of snap-trapped Yellow-cheeked Voles,

TABLE 4—Plant species associated with Yellow-cheeked Vole captures on two live-trapping grids near Chick Lake, Northwest Territories during 1974. Chi-square values were calculated from frequency of occurrence of plant species and frequency of capture of voles. Correlation coefficients were calculated from cover values of plant species and numbers of captures/TN of Yellow-cheeked Voles

	Grid A			Grid B		
	Chi square	<i>r</i>	df	Chi-square	<i>r</i>	df
Vascular plants > 0.5 m < 2 m in height						
<i>Alnus crispa</i>	12.083*	-0.389	18	0.135	+0.056	38
<i>Betula glandulosa</i>	5.099*	+0.663	7	0.002	-0.155	17
<i>Ledum groenlandicum</i>	4.024*	-0.078	32	0.236	-0.051	92
<i>Potentilla fruticosa</i>	7.910*	+0.306	20	0.123	-0.022	40
<i>Rosa acicularis</i>	3.74	+0.205	14	4.387*	-0.134	44
<i>Vaccinium uliginosum</i>	13.240*	-0.001	34	4.051*	-0.097	84
<i>Picea mariana</i>	9.071*	+0.192	41	4.931*	+0.151	76
Vascular plants < 0.05 m in height						
<i>Empetrum nigrum</i>	0.028	+0.745*	6	0.915	—	—
<i>Salix</i> sp.	1.199	-0.152	14	3.805	+0.919*	3
Gramineae	3.978*	+0.391*	28	10.987*	+0.033	44
<i>Linnaea borealis</i>	4.150*	+0.971	1	0.410	-0.119	27
Lichens						
<i>Cladonia mitis</i>	6.088*	+0.001	5	0.013	-0.130	66
<i>Peltigera</i> sp.	18.277*	+0.400	16	3.524	-0.144	60
Liverworts						
<i>Hedwigia</i> sp.	0.278	+0.141	19	1.185	+0.236*	78
Unknown species	—	—	—	9.086*	+0.127	59

+< 2 m in height.

**P* < 0.05.

and several voles were observed eating these berries near Chick Lake. It may be that demonstrations of habitat selection via trapping can be inaccurate and possibly in this situation completely opposite from the actual phenomenon.

Results of the micro-topography analyses suggested that micro-topography was probably more important to Yellow-cheeked Voles than were individual plant species. Correlation coefficients calculated for captures/100 TN versus degree of micro-relief for Grids A and B were $+0.967$ $P < 0.05$ and $+0.981$ $P < 0.05$, respectively. Greater micro-relief probably increased the amount of escape cover for these voles, especially in a forest with a moss- and lichen-dominated understory which provided little herbaceous escape cover.

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Nesting and Brood Ecology of Lesser Scaup at Waterhen Marsh, Saskatchewan

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Abstract. The nesting and brood ecology of the Lesser Scaup (*Aythya affinis*) was observed at Waterhen Marsh in central Saskatchewan. Most scaup nests were initiated during the first two weeks of June and the peak of hatching occurred during the middle two weeks of July. The mean clutch size was $9.70 \pm \text{SE } 0.21$ ($n = 56$); if clutches of 13 and 14 are omitted, the mean becomes 9.47 ± 0.18 ($n = 53$). Several incidents of egg parasitism involving scaup were noted. Insular, well-concealed nest sites featuring plants (especially grasses) in the 21- to 60-cm height range were often selected. Twenty-eight (76%) of 37 nests were successful. Striped skunks (*Mephitis mephitis*) and Common Crows (*Corvus brachyrhynchos*) caused most of the nesting failures. The high social tolerances exhibited by brooding scaup and the concentration of broods in areas of suitable habitat resulted in the formation of mixed broods. Redhead (*Aythya americana*) ducklings frequently joined these broods. Possible advantages of this cr ching are discussed.

Although the Lesser Scaup (*Aythya affinis*) is one of the most abundant ducks in North America, much remains to be learned about its spring and summer biology. Earlier studies dwelt on the life history of the species (Bent 1923; Kortright 1942; Gehrman 1951). More recently, food habits have been investigated (Rogers and Korschgen 1966; Dirschl 1969; Bartonek and Hickey 1969; Bartonek and Murdy 1970; Sugden 1973; others), as have features of the scaup's breeding biology (Rogers 1959, 1964; Dwernychuk 1968; Long 1970; Trauger 1971).

Previous authors have referred to the Lesser Scaup's habit of forming mixed broods that are often led by several hens (Munro 1941; Hochbaum 1944). A similar type of behavior has been frequently observed in scoters (*Melanitta fusca*), eiders (*Somateria mollissima*), and Shelducks (*Tadorna tadorna*) and has been interpreted as a form of cr ching or communal "baby-sitting" of the young (Koskimies 1955; Hild n 1964; Hori 1964; Ahlen and Andersson 1970; Gorman and Milne 1972). This differs from the formation of "giant broods" led by a single hen, typical of some species of the tribe Mergini (Hild n 1964).

During a 2-year study of the ecology of the Gadwall (*Anas strepera*), I had the opportunity to observe some aspects of the nesting and brood ecology of the Lesser Scaup. As mixed broods of scaup and Redheads (*Aythya americana*) were

frequent, this phenomenon was also investigated.

Study Area

Waterhen Marsh (50 51' N, 105 02' W) is located 8 km south of the town of Kinistino in the aspen parkland of Saskatchewan. The marsh was drained in the 1920s, but after agricultural attempts failed and a fire broke out in the underlying peat soils the basin was reflooded. An earthen dam, constructed in 1938 by Ducks Unlimited (Canada), aids in control of water levels in the 1530-ha impoundment (Figure 1).

The marsh basin is very shallow, exceeding a depth of 1 m only in the drainage ditches. The underlying soils have remained quite unconsolidated since the fire and this has prevented the establishment of rooted submergent vegetation in most portions of the marsh. Only in the northeast corner of the marsh are submergents, primarily spiked water milfoil (*Myriophyllum exalbescens*), abundant. Emergent vegetation, especially cattail (*Typha latifolia*), is a dominant feature of the marsh, covering 30–35% of the total area. Large bays of open water are separated by the cattail stands. Dense growths of cattails, sedges (*Carex* spp.), bulrushes (*Scirpus* spp.), and whitetop grass (*Scolochloa festuacea*) are present in the northwestern and southeastern corners of the basin.

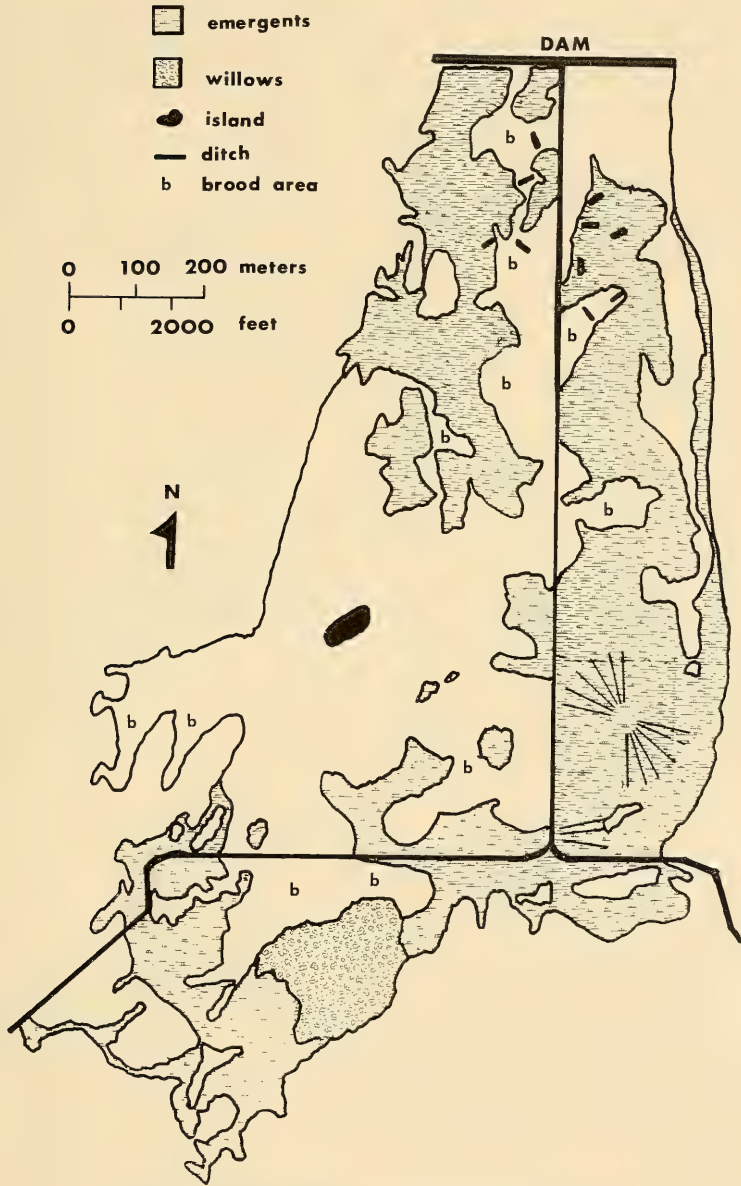


FIGURE 1. Waterhen Marsh, drawn from a 1970 aerial photo.

Throughout the marsh there are a great many aquatic invertebrates, which are an important source of food for waterfowl; two members of

the invertebrate fauna are the benthic midge or chironomid larvae and free-swimming cladocerans.

There were three types of habitat available for ground-nesting ducks at Waterhen Marsh: upland areas, ditchbanks, and islands. Ten rectangular artificial islands, each approximately 10×30 m in dimension, were constructed prior to the reflooding of the marsh and these, along with a 2.2-ha natural island, constitute most of the island habitat. Many of the ditchbanks have been substantially eroded by waves and are highly segmented and insular in nature.

Methods

Field work was conducted from the second week of May to the first week of September in 1972 and 1973. Nests were located by systematic inspections of the islands and part of the ditchbanks, and by less intensive searches of the upland areas. Most nests were marked, usually at a distance of 10 m away, with a small strip of red surveyor's tape. Other nests were relocated by topographic and vegetational features only. I tried to recheck nests once or twice before hatching to gather information on date of nest initiation and clutch size. Whenever possible, date of nest initiation, date of hatching, clutch size, distance from water, and fate of the nest were recorded. The plant species, canopy coverage, and height of vegetation at the nest site were also recorded. Canopy coverage above the nest was estimated to belong to one of six classes, following Daubenmire (1959): 0–5% canopy coverage, 5–25%, 25–50%, 50–75%, 75–95%, and 95–100%.

Brood observations were made from a canoe or motorboat, or by scanning the marsh from the uplands, ditchbanks, or islands. Use of 7- or 8-power binoculars and a 40-power spotting scope facilitated these procedures. The age of ducklings (see Gollop and Marshall 1954), the number of ducklings, the features of the habitat, and behavior of the broods were noted. When mixed broods were encountered, I tried to identify the ducklings to species, age, and number.

Results and Discussion

Nesting Chronology and Clutch Size

Lesser Scaup were among the most numerous ducks on the study area and were already present at the commencement of field studies in both

years. Many or all of these early migrants may have moved further north to nest (Trauger 1971). The peak of nest initiation did not occur until the first two weeks of June.

The most frequently occurring clutches were 10, 9, and 8 eggs respectively (Figure 2). If clutches of more than 14 eggs are considered as parasitized (Hildén 1964), the average clutch size is $9.70 \pm \text{SE } 0.21$ eggs ($n = 56$). If 12 eggs are considered as the maximum clutch (Weller 1959; Weller et al. 1969), the average is 9.47 ± 0.18 eggs ($n = 53$).

Compound clutches or dump nests, presumably resulting from two or more scaup hens laying eggs in a single nest, contained 16, 16, 17, 18, and 19 eggs, respectively. The habit of parasitic egg-laying has been frequently noted for this species and is known to occur both intra- and inter-specifically (Weller 1959; Vermeer 1968; Long 1970). At Waterhen Marsh, scaup eggs were frequently found in Gadwall nests, 26 of 295 completed Gadwall first clutches being parasitized. One scaup egg was found in each of 18 (69%) of the 26 Gadwall nests but as many as five eggs were present in one nest. The average first clutch size for Gadwall nests parasitized by scaup was 11.0 ± 0.3 Gadwall eggs as compared with 10.4 ± 0.1 for all normal first clutches. Therefore, egg parasitism did not reduce the average clutch size of the host duck. Weller (1959) and Joyner (1976) have shown that the clutch of the host species can be reduced in such instances.

Three scaup clutches of 9, 10, and 9 eggs found on the large natural island in 1973, contained 8, 6, and 6 Gadwall eggs respectively. As few other scaup clutches were found to contain Gadwall eggs and, as other studies show little evidence of a high rate of egg parasitism by Gadwalls, it is possible that these nests were initiated by Gadwalls and later taken over by scaup. No eggs of other duck species were found in scaup nests.

Nest-site Selection and Nesting Success

Although the nests of many dabbling ducks were found up to 500 m from the marsh edge, all scaup nests were found close to water. More than 50% of the nests were situated within 5 m of the water's edge and approximately 75% were within 10 m. Nest sites were usually dry and at least 30 cm above water. Many of the ditchbank

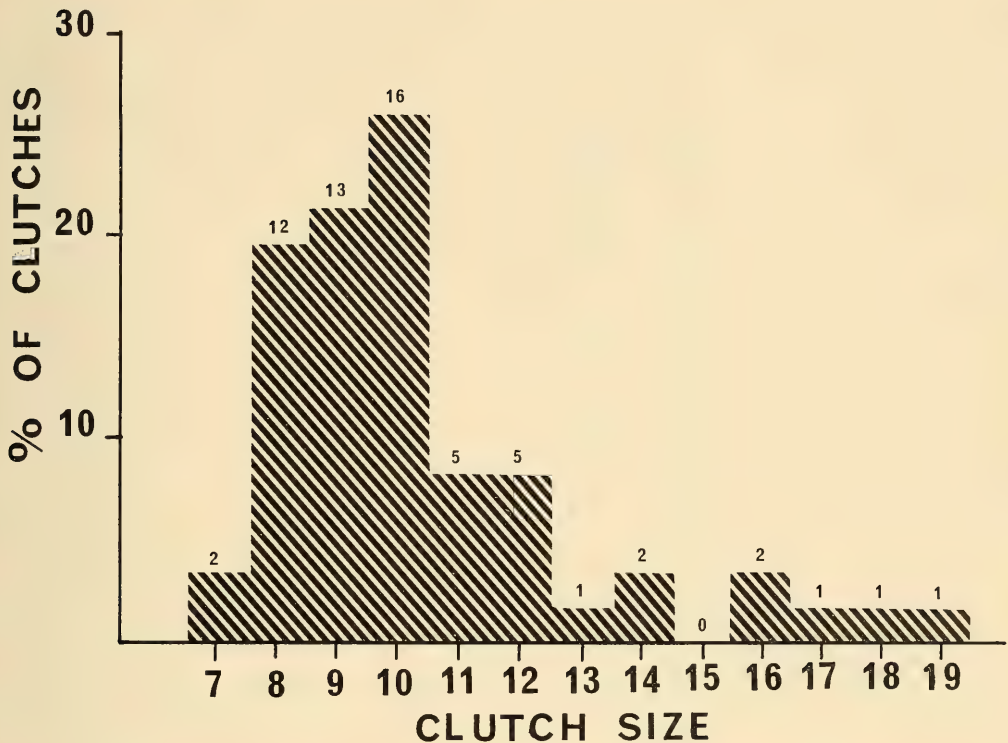


FIGURE 2. A frequency distribution of Lesser Scaup clutch sizes. The numbers of clutches are indicated above the histogram.

nests were situated right along the edge of the bank, within 1 m of water, in thick graminaceous (grassy) vegetation.

In contrast to dabbling ducks' nests, only 3 of 64 scaup nests were situated in upland areas, 18 were on the ditchbanks, and 43 were on the islands. As the ditchbanks were much divided by erosion, most of the nests there were essentially insular in nature. No nests were found among emergent plants, but these areas were not intensively investigated.

Scaup often used graminaceous cover for nesting (Table 1). Awnless brome (*Bromus inermis*) was the most common cover species, providing the greatest percentage of the canopy at 35% of the nest sites. Western snowberry (*Symphoricarpos occidentalis*) was the dominant at 19% of the nests, all on the large natural island. The only forb which was dominant at

more than one nest was Canada thistle (*Cirsium arvense*). Overall graminaceous plants were

TABLE 1—The dominant plant species at 54 Lesser Scaup nests at Waterhen Marsh

Species	Growth form	Nests
		Number (%)
<i>Bromus inermis</i>	graminaceous	19 (35)
<i>Symphoricarpos occidentalis</i>	shrub	10 (19)
<i>Carex</i> spp.	graminaceous	7 (13)
<i>Scolochloa festucacea</i>	graminaceous	6 (11)
<i>Cirsium arvense</i>	forb	6 (11)
Miscellaneous grasses	graminaceous	4 (7)
<i>Axyris amaranthoides</i>	forb	1 (2)
<i>Rosa woodsii</i>	shrub	1 (2)
Total		54 (100)

dominant at 67% of 55 nests, shrubs at 20%, and forbs at 13%.

The limited use of forbs as nesting cover is somewhat surprising, as plants of this physiognomy were an important cover species elsewhere (Dwernychuk 1968; Long 1970). At Waterhen Marsh, the stands of forbs such as common nettle (*Urtica gracilis*) and Russian pigweed (*Axyris amaranthoides*) appeared to be too tall to be readily used by scaup. Nesting females had great difficulty in getting airborne from these patches and apparently for this reason used mainly the edges of such cover.

Most scaup nests were situated in cover in the 21- to 60-cm height range (Table 2). Vegetation of 20 cm or less in height was avoided, presumably because it provided poor concealment. Nests in the taller height classes (> 60 cm) were normally located near the edge of the stands of vegetation as discussed above. Long (1970) found that Lesser Scaup preferred to nest in vegetation 15 to 34 cm in height. He believed that this resulted from the selection for cover which provided adequate concealment, yet did not too greatly obscure the hen's view of the surrounding area. At Waterhen Marsh, Lesser Scaup used decidedly taller vegetation than indicated in Long's study. The fact that many of the nests on his study area were in gull or tern colonies may have influenced the results. Hildén (1964) has shown that ducks will tolerate sparser cover than usual in order to nest among larids, an association from which they presumably receive protection against aerial predators.

TABLE 2—The distribution of Lesser Scaup nests as related to the height of vegetation

Height of vegetation (cm)	Nests
	Number (%)
0-20	3 (5)
21-40	22 (39)
41-60	22 (39)
61-80	4 (7)
> 80	5 (9)
Total	56 (99)

Lesser Scaup nests were usually well-concealed as compared with those of earlier nesting species. The average canopy coverage at 57 scaup nests was $35.7 \pm 3.6\%$, a figure which compares favorably with the $39.8 \pm 1.2\%$ average recorded for 382 Gadwall nests. The latter species has been noted for its preference for dense nesting cover (Duebbert 1966; Long 1970).

The fates of 37 Lesser Scaup nests were determined. Twenty-eight (76%) were successful (i.e., at least one egg hatched), eight (22%) were destroyed by predators, and one (3%) was deserted. The nesting success for 34 insular nests was 82%. The two common predators on the study area, the Common Crow (*Corvus brachyrhynchos*) and the striped skunk (*Mephitis mephitis*), caused most of the nest failure.

Other studies also indicate that the success of island-nesting scaup is normally high (Keith 1961; Townsend 1966; Vermeer 1968; Long 1970). Under such conditions nesting success should exceed 80% and, assuming a 39% rate of renesting by unsuccessful hens (Keith 1961), more than 85% of the island-nesters should hatch successful clutches. Provision of suitable island habitat for scaup is a good management practice since the upland nests of this species are often destroyed by skunks and other predators (Keith 1961; Rogers 1964).

Hatching and the Brood Period

The peak of hatching was determined by backdating aged broods (Figure 3). Nearly all the successful scaup clutches hatched in July, especially during the middle two weeks of that month. Redhead clutches showed a similar but slightly earlier hatching chronology than did Lesser Scaup. The overall nesting chronology for scaup at Waterhen Marsh corresponds fairly well with that presented for central Alberta by Dwernychuk (1968).

After hatching, scaup broods moved to the shallow bays protected from the wind by emergent vegetation (Figure 1). In these bays submergent plants were very sparse but aquatic invertebrates, especially chironomid larvae, were abundant (unquantified observations). The importance of such invertebrates in the diets of young scaup has been previously described (Bartonek and Hickey 1969; Bartonek and Murdy 1970; Sugden 1973).

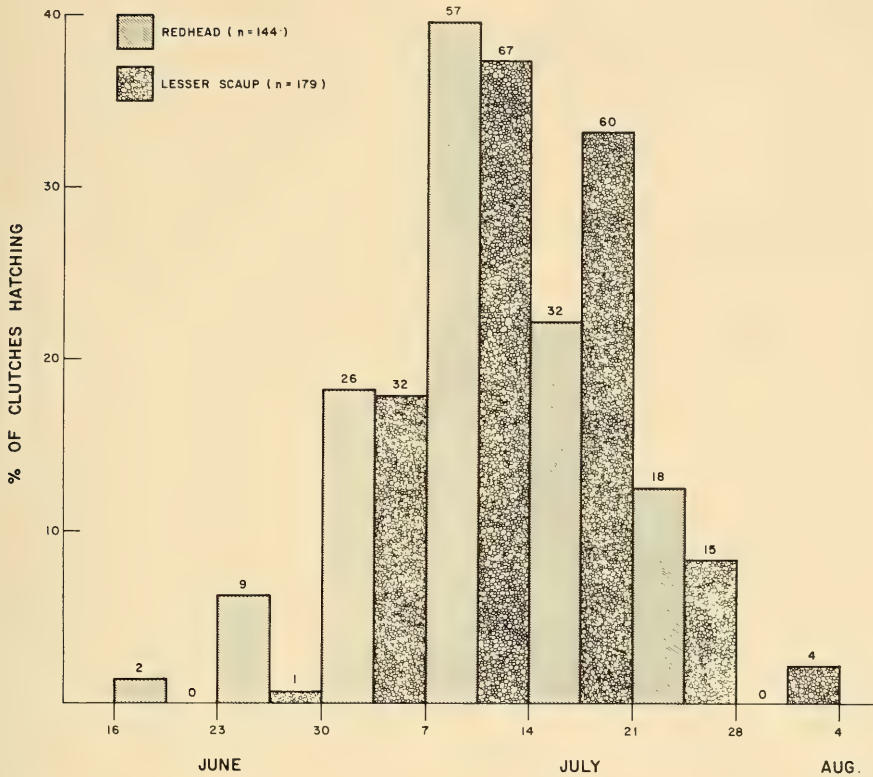


FIGURE 3. The peaks of hatching of Lesser Scaup and Redhead broods at Waterhen Marsh.

Many broods of Redheads were also observed in these areas. The preference for similar habitats by scaup and young Redhead broods, and the large populations of both species present, resulted in a great number of ducklings being concentrated into rather small areas. As a result, mixing of broods occurred commonly. Scaup broods readily joined together since female scaup made little effort to drive away other hens or ducklings. Redhead broods were frequently deserted by their mothers, which typically showed low maternal drives. These ducklings readily joined the scaup broods with no apparent conflict resulting. In contrast to the scaup ducklings, the young Redheads remained close together and appeared to retain their identity within the mixed broods. Mixed broods

of scaup were observed to come together and later separate with frequent interchange of ducklings. Female scaup showed little discrimination in allowing ducklings to follow them. The brood following a scaup in many cases consisted of more Redhead than scaup ducklings.

Mixed broods or crèches often consisted of ducklings of several age classes. The largest brood totaled more than 100 scaup ducklings and was accompanied by six hens. Typical crèches contained from 15 to 40 scaup ducklings and were led by two or three hens. By early August, most of the ducklings, except those isolated from the major brood areas, were part of the crèches. At this time, most of the Redhead offspring had been deserted by their mothers and

had also joined the large scaup broods.

The mixing of broods made it difficult to determine the attrition of brood size as time went on. The average size of 78 isolated Class 1a broods (1 to 6 days old), believed not to have mixed with other broods, was 8.5 ± 0.3 ducklings.

Because of the late-nesting habit, scaup and Redhead ducklings lagged behind other waterfowl in attaining flight. By adding the average age at first flight to the known date of hatching for the broods, the expected date of the onset of flight was calculated. Ages at first flight average about 49 days for Lesser Scaup (Gollop and Marshall 1954; Rogers 1962; Bellrose 1976) and 57 to 63 days for Redheads (Weller 1957; Smart 1965). Although Redheads showed a slightly earlier hatching chronology (Figure 3), they were later in achieving flight than were the rapidly developing scaup. By the opening of hunting season on 9 or 10 September, a maximum of 90% of the Lesser Scaup and 65% of the Redhead broods could fly. Under conditions of high early-season hunting pressure, local populations of these species could suffer severe losses.

The Significance of Crêching Behavior

The formation of crêches by Lesser Scaup appeared to arise because of three main conditions. First, scaup showed a relatively dense breeding population, high nesting success, and a fairly synchronized hatching period, resulting in a large number of similar-aged broods being present on the marsh at the same time. Second, there was a limited amount of suitable sheltered habitat for these broods during periods of windy weather and, consequently most broods assembled in the sheltered areas. The third and probably most important condition leading towards crêching behavior was the high degree of tolerance, or perhaps even attraction, between different hen scaup and their broods. Scaup made no effort to drive away approaching hens with broods.

Crêching provides several possible advantages to the participating waterfowl species. Lack (1947) drew an analogy between this behavior in eiders and a convoy system; he suggested that in the larger broods, each female has a smaller periphery to patrol, thereby giving better

protection against predators. Kear (1970) suggested that crêching reduces aerial predation, as larger broods are more liable to spot approaching enemies and can huddle together for protection. Further evidence of this advantage is presented by Ahlen and Andersson (1970) and Gorman and Milne (1972).

In the Shelduck, which in Britain undergoes an annual molt migration, the ducklings are left behind under the care of a few adults. This removes the responsibility for the care of young from most adults, which can then depart for the molting grounds (Hori 1964). Crêche formation also allows more broods to use a limited amount of habitat or other restricted resource. This has been suggested for the Velvet Scoter (*Melanitta fusca*) by Koskimies (1955).

For the Lesser Scaup, all three of these advantages could be operating. When large broods were approached by boat or canoe, two or sometimes three hens would rush at the observer tolling or feigning injury while the other hen(s) attempted to lead the brood away. Munro (1941) has reported similar behavior by scaup. Because duckling predators were not overly numerous on the study area, I did not get a chance to observe any interactions between scaup broods and their enemies.

The high number of ducklings per brooding hen in the crêches suggests that many hens had deserted their broods. Presumably these unattached hens would have more time to undergo the post-nuptial molt before autumn migration.

Finally, scaup broods were observed to prefer calm water areas where food was abundant. On windy days, which are frequent on the prairies, the availability of such habitat is limited. Crêching allows scaup to use this habitat optimally.

The mixing of Redhead ducklings with scaup broods is perhaps a further development of the parasitic habit shown by the former species in its nesting ecology. The young Redheads benefit from the protection afforded by the strong maternal drives of the scaup and the crêching system. The hen Redheads can molt sooner than they otherwise might if they were still responsible for their ducklings. In late-nesting species such as the Redhead or Lesser Scaup, this could be of survival value as it allows earlier migration by most of the adult population.

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The Genus *Crangonyx* (Amphipoda: Gammaridae) in the Central Connecticut River System

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Abstract. The genus *Crangonyx* is represented in the central Connecticut River system by two poorly known species complexes, *C. richmondensis* and *C. pseudogracilis*. Examination of large series of specimens has provided ecological, distributional, and variational data for each species and has extended the zone of intergradation between *C. r. richmondensis* and *C. r. laurentianus*. A hypothesis is provided that considers glacial isolation as the factor causing differentiation in Atlantic coast populations of each species. *Crangonyx r. richmondensis* is considered to have re-entered New England by means of ice-contact migration while *C. pseudogracilis* is believed to have re-entered by way of coastal flooding.

Introduction

In a recent paper on North American freshwater amphipods, Holsinger (1972) discusses taxonomic difficulties among certain widely distributed species groups, particularly *Crangonyx pseudogracilis* Bousfield and *C. richmondensis* Ellis *sensu lato*. The problem involves insufficient distribution data for described species, and samples from given areas too small to furnish adequate information on limits of variation.

The present study attempts to analyze, both systematically and zoogeographically, populations of each species from the Connecticut River valley in the central New England Upland. Ecological observations have been presented for comparison with existing life-history studies and to provide information relevant to zoogeographical patterns. Emphasis has been placed on examining large series of specimens representing each species in order to provide as completely as possible the relationships of central New England populations with others of the same complexes in neighboring regions. Interpretation of the systematic status of *Crangonyx* in the Connecticut River valley relies on a proposed distributional history that accounts for the morphological characteristics observed in populations occurring in New England.

Crangonyx pseudogracilis Bousfield

Between April and July 1976, 216 specimens of *C. pseudogracilis* were collected from 10 localities in the Connecticut River. All localities lay within Massachusetts boundaries and included Franklin, Hampshire, and Hampden

Counties, or a distance of about 100 river kilometres. These were supplemented by 16 specimens taken earlier from the same river areas during May and June of 1975. All material has been placed in the Museum of Zoology, University of Massachusetts at Amherst.

Also examined were nine specimens collected by E. Mills (Yale Peabody Museum Number 5473) from Axelshop Pond, Mount Carmel, New Haven County, Connecticut.

Bousfield (1958) has included Atlantic coast streams within the range of this species. He also indicated that *C. pseudogracilis*, as a lowland river and pond species, was found in a variety of aquatic habitats. In the Connecticut River in Massachusetts, *C. pseudogracilis* is restricted to the river and its immediate floodplain. Intensive surveying of the entire drainage system in the state over the past three years has failed to produce specimens in any of the accessory habitats listed by Bousfield (1958). A population of *C. pseudogracilis* occurs, however, in the upper Quinnipiac valley west of the Connecticut valley in Connecticut (Mills 1964).

Ovigerous females, occasional subadult females, and adult males mass along the shoreline in bays and oxbows from late April through mid-June. Individuals accumulate in vegetation and under rocks at the shore margin and are often found in stranded pools and rivulets formed by receding water levels. Immatures appear by the first week of June. Adult non-breeding and breeding females and males have been taken in mid-stream near bottom during late May and June and in early July.

The *C. pseudogracilis* species complex is a

poorly understood group discontinuously distributed over greater south-central North America. The group is characterized by comb spines on the outer ramus of uropod 2 in males and weakly spined palm margins on the propods of pereopods 1 and 2.

In the Connecticut River, individuals vary morphologically from the nominate populations examined by Bousfield (1958) in a few minor but consistent ways. Although generally resembling typical *C. pseudogracilis* from the Great Lakes drainages, as described by Bousfield (1958), Connecticut River specimens are distinguishable by a strongly mucronate posterolateral angle of epimeron 1 and the occurrence of only two to three groups of variable-length setae on the posterior margin of segments 4 and 5 on antenna 2.

A quantitative assessment has shown divergences in some meristic characters as well. In adult females, a tendency to increase the number of apical spines on the telson lobes and to decrease spines on the posterior angle of the second gnathopod is evident. Furthermore, although considerable overlap exists, Connecticut River specimens are somewhat smaller than Great Lakes forms.

Values and ranges for some variable characters have been analyzed (Table 1). A comparison of the degree of variability within included characters shows that there is often a wide range of values for a given character and, in a few instances, that the frequency of variation is not so subtle.

The presence of observed differentiation in some external features, combined with wide variability in others, may reflect evolutionary mechanisms acting upon an isolated population existing, for much of the Pleistocene Epoch, in restricted habitats in the Atlantic coastal plain (see Historical Zoogeography section).

Crangonyx richmondensis Ellis

During the months of March and April 1976, three populations of *C. richmondensis* were sampled. The collections, totaling 204 adult specimens plus additional unlisted immatures, were all taken in Massachusetts from three localities: Sunderland, Franklin County, Cranberry Pond, 35 females, 9 males; Leverett, Franklin County, wooded vernal-autumnal

TABLE 1.—Meristic character frequencies of *Crangonyx pseudogracilis*¹ (female, N = 113; male, N = 32)

Character (female)	Range	Mean ± SD
Propod, Gnathopod 2, posterior		
angle margin		
inner spines	3–5	3.5 ± 0.55
outer spines	1–3	2.1 ± 0.41
superior medial setae	6–10	7.8 ± 0.76
Pereopod 7, posterior		
serations of basis	10–16	13.4 ± 0.78
Abdominal side plate 2,		
sub-marginal spines	2–7	4.3 ± 1.03
Spines per telson lobe	2–6	3.7 ± 0.69
Uropod 3, outer ramus,		
outer spine sets	3–5	3.7 ± 0.50
Length (mm)		
males	4–5	4.3 ± .35
females	6–10	8.1 ± .89

¹All specimens adults.

pond, State Route 63, 13 km north of Amherst center, 59 females, 14 males; and Amherst, Hampshire County, wooded pond, State Route 9, 3 km east of center, 47 females, 40 males.

All the localities listed above are small depressions in unconsolidated glacial-drift deposits filled by ground water and run-off. Each pond remains cool throughout summer. Water levels in each, except Cranberry Pond, fluctuate considerably during the year. Oviparous females are present in early March and persist until at least early May. Bousfield (1958) has indicated that this species occurs in acid waters in parts of its range. The habitats of presently discussed populations maintain neutral pH within the species life zone (Keene 1968; L. Raboin, personal communication).

My analysis of subspecific characters follows Bousfield's (1958) criteria for distinguishing *C. r. richmondensis* and *C. r. laurentianus*. These include the number of apical spines per telson lobe, acuteness of posteroventral angles of the abdominal plates 2 and 3, and total length of mature specimens.

Apical spines were counted on all specimens except those with damaged telsons (four individuals). Spine counts ranged from one to four per lobe, although one- and four-spined lobes were rare and have been ignored in

analysis. The normal arrangement was 2-2, 3-2, or 3-3. Spine counts varied both within and between populations. In Leverett and Amherst populations, 53.5% and 65.0%, respectively, had spine combinations of 2-2, indicating *C. r. laurentianus*, whereas 61.0% of the Sunderland population had 3-3 combinations, suggesting *C. r. richmondensis*. The reciprocal even combination occurred only in 7-17% of each; however, 3-2 combinations made up 16.0-29.5% of the remaining specimens.

Total percentages of combined populations show a tendency towards *C. r. laurentianus* with 48% having 2-2 combinations, the other two combinations occurring about 25% of the time.

Determining the subspecific value of the second and third abdominal plates (epimera) is subjective, as the character is nonmeasurable. Figure 1 shows the typical degree of development of the plate angles in all populations.

Total lengths for each subspecies have been listed by Bousfield (1958) as 12 to 14 mm for females in *C. r. richmondensis*, and 14 to 18 mm for females and 9 to 11 mm for males in *C. r. laurentianus*. Mairs (1970) gives 9.9 to 13.0 mm and 6.7 to 8.5 mm for females and males, respectively, for *C. r. richmondensis* in Maine. I observed considerable variation in inter- and intra-population length measurements. Consequently, subjectivity was again applied in determining overall characteristics. Sunderland and Leverett populations had lengths ranging from 13.5 to 18.5 mm and 14.0 to 19.0 mm, respectively, for females, and 10.0 to 13.0 mm and 12.5 to 18.0 mm, respectively, for males. These are typical for *C. r. laurentianus*. In

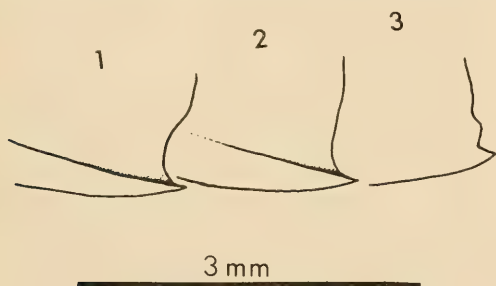


FIGURE 1. Epimeral plates 1-3 of *Crangonyx richmondensis*.

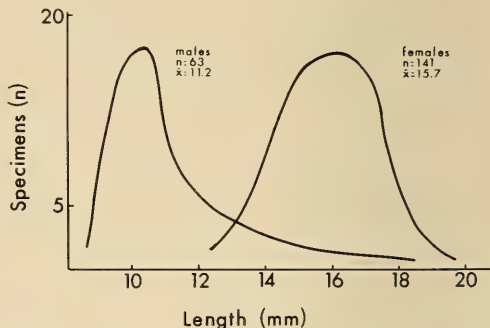


FIGURE 2. Length curves of three populations of *Crangonyx richmondensis*.

contrast, Amherst specimens had lengths of 12.5 to 17.5 mm and 9.0 to 12.0 mm for females and males, respectively, which is intermediate between both subspecies. Figure 2 illustrates combined values for each sex.

Substantial variation occurs among local populations as demonstrated by inconsistencies in discussed characters. The Sunderland population contains apical spine counts, suggesting *C. r. richmondensis*, but length ranges that imply *C. r. laurentianus*. The reverse prevails in the Amherst population. Leverett animals generally tend toward *C. r. laurentianus* in all characters. These results agree with Bell's (1971) analysis of Vermont specimens. Although he "provisionally" assigned the material to *C. r. laurentianus*, his examined specimens had length features of *C. r. laurentianus* and apical spine counts of *C. r. richmondensis*. It therefore seems unwise to consider the west-central New England forms as belonging to either subspecies. The zone of intergradation between both subspecies is then extended eastward from central New York (Holsinger 1972) to include west-central New England (Figure 3). This wide gap between seemingly good subspecies may represent a non-clinal continuum resulting from mixing of two differentiated forms reinvading formerly glaciated areas (see Historical Zoogeography section).

Historical Zoogeography

It is beyond the scope of this paper to recount the history of the genus *Crangonyx* in eastern North America. The occurrence of two seem-

ingly divergent forms of two widely distributed species in northeastern North America, however, warrants some discussion as to their possible origin. The effects of the Appalachian Divide on the derivation and distribution of freshwater animals is well established (Ortmann 1913; Johnson 1970). Advance of the Wisconsin ice sheet in the latter phases of the Pleistocene Epoch compressed and isolated the Atlantic coast fauna into refugia south of the ice sheet (Johnson 1970; Dadswell 1974). The position of the terminal moraine (Flint 1971) indicates that the lower coastal portions of the Susquehanna, Potomac, and Delaware River basins probably served as these refugia although the existence of refugia as far north as the exposed continental shelf areas, including Long Island Sound and Narragansett Bay (Curry 1965), has been postulated (Dadswell 1974).

With the final retreat of the ice from New England during the closing phases of the epoch, avenues for dispersal became available for re-invading aquatic animals. Interdrainage passages could have been negotiated either by coastal flooding along dilution zones at river mouths, by stream capture (Ross 1974) or by occupation of successional proglacial lakes, a means apparently unique, as presently known, to late-glacial events (Crocker 1957; Frey 1965; Dadswell 1974, 1975). Proglacial lake invasion, herein referred to as ice-contact migration, and stream capture would have been the only means available to animals emigrating from interior Mississippian refugia via Hudson-Champlain regions into the Connecticut valley and adjacent streams. Animals moving north from southern Atlantic glacial refugia could utilize all three methods discussed above.

Due to the persistence of the major geological and topographic features of New England through the Pleistocene Epoch (Schafer and Hartshorn 1965) it is doubtful that stream capture between the Connecticut River and western systems including the Hudson and Lake Champlain drainages existed long enough, if at all, to allow faunal exchange (see Brooks and Deevey 1963, p. 150). Biological evidence in the form of non-passively distributed headwater forms is absent. The small crayfish *Cambarus bartonii* (Fab.) has been implicated as a typically stream-capture distributed species (Ortmann

1913; Crocker 1957). It commonly occurs northward in the upper Hudson River system (Faxon 1885; Crocker 1957), in the Champlain – St. Lawrence watersheds (Bell 1971), and has apparently entered the St. Johns River system in Maine (Faxon 1885), but has never been reported from the headwaters of any Connecticut River tributaries. Even the existence of an ice “tongue” that temporarily halted in the Champlain lowland (Lougee 1939; Schafer and Hartshorn 1965), forming ice-marginal lakes that drained to both the Connecticut River and glacial Lake Vermont (Loveville – Fort Ann Lake succession of Coates 1976), now represented by Lake Champlain, did not permit an exchange of fluvial life forms. Re-invasion of the Connecticut and adjoining eastern valleys from the interior by means of ice-contact migration apparently occurred for a few cold-water lakewelling fishes (Brooks and Deevey 1963), but not for cold-water lentic invertebrates (Dadswell 1974). It is suggested, therefore, that principal reoccupation of the southern New England Upland and possibly other northeastern areas by both species of *Crangonyx* occurred from isolated areas to the south. This is further supported by the present analysis of their morphology, distribution, and ecology. Moreover, the proposed methods and direction of migration used by each species possibly correlates with a sequence of recolonization “waves” (Adams 1902) that included several groups of aquatic animals emigrating from southern Atlantic refugia.

Crangonyx richmondensis, as previously mentioned, occurs in water-filled kettle holes in unconsolidated stratified drift deposits typically created in ice-contact zones by meltwater streams. A definite correlation also exists between the presence of adult *C. richmondensis* and seasonally cold water situations (Judd 1963; Sprules 1967; Mairs 1970), implying a historical affinity of this species for cold water. Furthermore, in formerly glaciated regions, this species is restricted to small lentic water bodies (Bousfield 1958).

Crangonyx r. richmondensis probably left its proglacial refugia and followed closely the retreat of the ice sheet to the north by way of ice-contact migration. With abandonment and

subsequent isolation of ice-formed, water-filled depressions and kettle holes, *C. r. richmondensis* found refuge, surviving in those areas able to maintain low water temperatures and other environmental requirements, including avoidance of excessive siltation and in-filling. The known localities for *C. richmondensis* in south-central New England lie outside the influence of heavy sedimentation typical of larger, temporary glacial lakes. *Crangonyx r. richmondensis* eventually migrated north of the Appalachian divide. Northwestern migration brought *C. r. richmondensis* in contact in valley areas with *C. r. laurentianus* migrating northeasterly from Mississippian refugia. This mixing resulted in interbreeding among populations of each subspecies, thus creating the observed wide band of variability that presently exists (Figure 3).

During the latter stages of glacial recession *C. pseudogracilis* followed the same northerly route along the Atlantic coast as was suggested



FIGURE 4. Proposed track utilized by the eastern glacial isolate *Crangonyx pseudogracilis* during postglacial dispersal. See Figure 3 for map key. Shaded area depicts known present distribution of the species in study area.

for the two crayfish *Orconectes limosus* (Raf.) and *Procambarus a. acutus* (Harland) by Ortmann (1906) and Crocker (1957) (Figure 4). Dispersal probably was controlled by flooding processes in coastal zones correlated with a rising sea-level. A review of the ecology of *C. pseudogracilis* in this study and in Bousfield (1958) shows that this species is a lowland river and pond inhabitant. Observations discussed earlier indicate an annual shoreward migration in spring. Animals massing in shallows near river mouths during spring floods could move between drainage basins.

Adventives of *C. pseudogracilis* most likely entered the southern Connecticut coastal plain during glacial Lake Hitchcock times, in the period following the Middletown re-advance about 13000 B.P. Between the time of glacial lake formation and final draining about 10700 B.P. (Schafer and Hartshorn 1965; Hartshorn 1969) *C. pseudogracilis* spread northward through the temporarily common Quinnipiac-Farmington valley lake-drainage system (Lougee 1938) as indicated by the presence of a relict population (E. Mills collection).

Further eastward, the species entered the Connecticut Valley and passed northward through the New Britain spillway into Lake Hitchcock, extending at least to the Turners Falls bedrock barrier. Crustal upwarping, following lake drainage, increased the incipient



FIGURE 3. Proposed tracks utilized by the eastern glacial isolate *Crangonyx richmondensis richmondensis* during postglacial dispersal. Shaded area depicts zone of intergradation of both species. Map key: D = Delaware River, H = Hudson River, C = Connecticut River, M = Mohawk River, LO = Lake Ontario, LC = Lake Champlain; dashed line = Terminal moraine of Pleistocene glaciation, solid line = Appalachian Divide, arrows = direction of dispersal, 18000 B.P. shoreline during maximum glaciation follows Curry (1965).

river's gradient downward to the south. This caused increased downcutting and eventual draining of former lake basin areas. *Crangonyx pseudogracilis*, having just occupied the lake, possibly was trapped by the sudden physiographic changes brought about by upwarping and as yet, has not left the immediate river valley.

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Pteridophytes of the Regional Municipality of Waterloo, Ontario

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Campbell, Craig A. and Donald M. Britton. 1977. Pteridophytes of the Regional Municipality of Waterloo, Ontario. *Canadian Field-Naturalist* 91(3): 262–268.

Abstract. Sixty-eight taxa of pteridophytes are listed for Waterloo Region, consisting of 51 species and 17 hybrids, varieties, and forms. Eleven species and 13 hybrids, varieties, and forms are new additions to the published flora, our knowledge of which was based on the pioneering work of William Herriott around 1900, and F. H. Montgomery in the 1940s. The status of rare or scarce pteridophytes in the region is discussed, and nine species that could not be found after 10 years of field work but might be expected to occur in the region, are enumerated.

Key Words: pteridophytes, Waterloo region Ontario, additions to flora.

The earliest known check list of pteridophytes of Waterloo County (now the Regional Municipality of Waterloo) was the unpublished one of William Herriott of Galt (now Cambridge). This list is undated, but an annotation indicates a date of *circa* 1926. Herriott listed 29 taxa of ferns only. Montgomery (1945) with reference to Herriott's collections and his own field work, wrote "A Botanical Survey of Waterloo County." Forty-three taxa of pteridophytes, 32 of these ferns, were recorded in it.

For almost 25 years after this, no systematic work was done on the Waterloo County flora. From 1959 on, Britton has been studying the biosystematics of *Dryopteris*, making collections in the Waterloo region. Since 1967, Campbell has been reinventorying the flora of the area, an imperative undertaking because of rapid urbanization. Persons associated with the University of Waterloo and Wilfrid Laurier University have also been engaged in such a resurvey.

In addition to extensive field searches for pteridophytes in the Waterloo region, we have examined specimens in the following herbaria: CAN, DAO, HAM, LKHD, NFO, OAC, QK, TRT, TRTE, UWO, WAT, WIND, WLU.

Literature and specimens from surrounding areas within the Great Lakes basin were also examined for comparative purposes.

In general, we have followed the nomenclature of Wherry (1961). Where these names

differ from those used by Fernald (1950) and Montgomery (1945), the synonymy is given.

To indicate status within the region, we have used the following code: 1 to 2 locales, rare; 3 to 5, scarce; 6 to 10, occasional; 11 to 20, frequent; over 20, common. In addition, an indication of abundance at some sites has been given. With rare species, we have tended to emphasize their history in the region.

We endeavored to check all stations of rarer taxa, as well as all reports of them. Representative collections were made of most common taxa. Collections made from 1967 to 1976 by Campbell and associates are largely in the herbarium of Wilfrid Laurier University (WLU). Duplicates of some have been deposited in the National Museum Herbarium, Ottawa (CAN). The classification of the Pteridophyta is in a state of flux at this time. The system we have adopted is that of Crabbe et al. (1975). This system is noteworthy in placing many of our ferns in the family Aspleniaceae and only one (*Polypodium*) in the Polypodiaceae. For simplicity and clarity, we have grouped the numerous *Dryopteris* hybrids into one section, whereas three *Equisetum* hybrids are integrated into the *Equisetum* sequence.

We have ignored trivial ecological or mutant forms and varieties, but have attempted to encompass those varieties, forms, and hybrids which are considered important by the leading pteridologists of today.

Lycopodiaceae

**Lycopodium annotinum* L. Scarce; recorded from five stations, numerous at one, a white spruce bog at Kossuth, *Campbell and Lamb* 70-7 (WLU). Others under hemlock in old mixed forests at Erbsville, Sunfish Lake, and Bamberg (*Wellwood* 2018, *Campbell and Pratt* 71-71, *Campbell and Diebolt* 75-93 [all WLU]). Also at Spongy Lake (*Lamb s. n.*, WLU).

Lycopodium clavatum L. Occasional. Collected at nine locations, but sparse; e.g., spruce bog, Kossuth, *Campbell and Lamb* 70-6 (WLU), Idlewood Park, Kitchener, *Campbell and R. Britton* 75-15 (WLU), Hidden Valley Road, Kitchener, *Campbell et al.* 71-74 (CAN). Only earlier collections from Galt "near old sawmill" along Mill Creek, No. 228 and Gibson's Woods, North Dumfries Township, No. 229 (*Herriott* in OAC).

Lycopodium complanatum L. var. *flabelliforme* Fernald (in Montgomery (1945) as *Lycopodium complanatum* L.). Scarce; collected at four stations, and sparse. Montgomery (1944) reported it only at Orr's Lake, North Dumfries Township, concession XI, lot 17, *Herriott* Acc. No. 226 (OAC); mixed woods 1 mi (1.6 km) south of Crosshill, *Campbell* (8); Idlewood Park, Kitchener, *Campbell and Lamb* 70-8; Dryden Tract, North Dumfries Township, concession IX, lot 21, *Campbell and Diebolt* 75-86 (all WLU). At the last site, a large infertile colony apparently adventive into 15-year-old pine plantation on edge of hardwoods.

**Lycopodium inundatum* L. var. *inundatum*. Rare, as it is elsewhere south of the Precambrian Shield in Ontario. Open, highly acidic, sphagnum bogs; in small, sparsely-vegetated depressions; *Herriott's Bog*, 3 mi (4.8 km) south of Galt (this location also known as Oliver's Pond, in North Dumfries Township, concession VIII-IX, lot 6), *Montgomery* 1561 (OAC) and also from here, *Britton and Campbell* 75-157(2) (WLU). Sight record: Grass Lake (Paris Cranberry Bog), North Dumfries Township, concession VII, lots 17, 18, R. MacLaren in 1975.

Lycopodium lucidulum Michaux. Frequent.

Lycopodium obscurum L. Occasional in dryish mixed woods. The typical variety and var. **dendroideum* D. C. Eaton are both represented in the collections, e.g., *Wellwood* 2070 (WLU) from Spongy Lake, and *Wellwood* 622 (WLU) from Erbsville, respectively. As Gleason (1952) notes, these two varieties seem to intergrade.

Selaginellaceae

Selaginella apoda (L.) Fernald. Occasional. Collected at seven localities; damp marly river, stream, and lake banks; also limy meadow and mossy edge of cedar swamp. *Herriott*, west side [of Grand River below Galt], No. 224 (OAC), Sunfish Lake, open meadow, *Britton and Peterson* 1452 (OAC), Blair Swamp, Beasley's old survey, lot 3, bank of rill, *Campbell et al.* 72-46 (CAN) are representative collections.

Equisetaceae

Equisetum arvense L. Common. Some collections have been identified as var. **boreale* Ruprecht: *Campbell* 72-38 (WLU), 73-30 (CAN), for example; these were from wet, forested localities.

Equisetum fluviatile L. (formerly *Equisetum limosum* L.). Occasional, in bogs, lakes, marshes, and along waterways and ditches; sometimes numerous.

Equisetum hyemale L. (*Equisetum prealtum* Raf. in Montgomery (1945)). Frequent. We have only var. *affine* (Engelmann) A. A. Eaton.

**Equisetum hyemale* var. *affine* × *Equisetum laevigatum* (= *Equisetum* × *ferissii* Clute). Rare. Quite numerous at the one location on damp sand floor of gravel pits, along a ridge, Hidden Valley Road, Kitchener, *Campbell et al.* 74-316 (WLU), *Britton* 3343 (OAC). These collections were determined by R. L. Hauke.

**Equisetum hyemale* var. *affine* × *Equisetum variegatum* (= *Equisetum* × *trachydon* A. Braun). Rare. Few at one location in gravel pit on Bird Ridge, Hidden Valley Road, Kitchener, August 1975, *Anderson s.n.* (OAC).

**Equisetum laevigatum* A. Braun. Scarce. Sparse to numerous at three locations in the region; a small seepage area at source of Patterson Creek, Beake Pond (= Taylor Lake) south of Cambridge, *Campbell et al.* 74-303 (WLU), *Britton* 3335 (OAC); damp floors of abandoned gravel pits. Hidden Valley (Bird Ridge) Road, Kitchener, *Campbell et al.* 74-176 (WLU), *Britton* 3341 (OAC). Determined by R. L. Hauke. Railway ditch. Galt [Cambridge], *Montgomery* 15-39 (TRT), reported by Montgomery (1945) as *Equisetum prealtum* Raf. and revised by Taylor and Boivin to *Equisetum laevigatum*. Typically a western species.

**Equisetum laevigatum* × *Equisetum variegatum* (= *Equisetum* × *nelsonii* (A. A. Eaton) Schaffner). Rare. Beake Pond, *Britton et al.* 3973 (OAC), determined by R. L. Hauke; along Blair-Galt Road, *Campbell et al.* 75-120(2) (WLU).

**Equisetum pratense* Ehrhart. Scarce. Occurs at three locations in small patches surrounded by *Equisetum arvense*; sites are moist or springy shaded areas, in rich

*Taxon new to the published flora of the Regional Municipality of Waterloo.

organic soil or sand; Homer Watson Park, Kitchener, *Campbell and Schaefer* 74-107 (WLU, CAN), *Campbell and Donaldson* 74-123 (WLU), and Strasburg woods, Kitchener, *Campbell and Diebolt* 75-79(4) (WLU); Spongy Lake, *McIntosh et al.*, 29 September 1976 (OAC). More common northward in Ontario.

Equisetum scirpoides Michaux. Occasional.

Equisetum sylvaticum L. Occasional. Apparently localized in cedar swamps and bog margins and sometimes climax mixed forests near water; abundant only at Paradise Lake. Some sites are Roseville Swamp (North Dumfries Township, concession IX, lot 27), *Campbell* 69 s. n. (WLU); Idlewood Park hydro corridor, Kitchener, *Campbell and R. Britton* 72-73 (WLU), St. Agatha (Wilmot Township, concession 1 of Block B, lot 3), *Campbell and Donaldson* 74-13 (WLU). Varieties and/or forms were not considered.

Equisetum variegatum Schleicher. Occasional, but localized in limy regions along rivers and streams; also in marl meadows; abandoned gravel pits where probably adventive. A luxuriant colony occurs at West Montrose, Highway 86 bridge, northeast bank of Grand River, *Campbell and Bald* 73-40 (CAN). Montgomery (1944) recorded only one station: Hogg's swamp at the riverside, Galt, 15 June 1894, *Herriott* (OAC), now a landfill site.

Ophioglossaceae

Ophioglossum vulgatum L. var. *pseudopodium* (Blake) Farwell. Rare; collected only at Sunfish Lake near Erbsville in 1940, *Montgomery* 445 (OAC). Repeated searches by the authors for it here failed.

Botrychium dissectum Sprengel. Occasional; collected at eight locations, few in number in hardwoods (often beech-maple) or rich mixed forests. Forma **dissectum* Sprengel, Ridgeway Drive, Cambridge, *Campbell et al.* 72-47 (CAN) and Bamberg, *Campbell and Diebolt* 75-89 (WLU). Forma *obliquum* (Muhlenberg) Fernald represented by Freeport, *Montgomery* s. n. (OAC Acc. No. 1619) in 1947 and Crosshill, *Campbell and England* s. n. (WLU Acc. No. 4719). One intermediate between these two formae from Crosshill site (WLU Acc. No. 47-20). Variety *oneidense* (Gilbert) Farwell has been found only twice: once at Shoemaker's Woods, Kitchener, *Montgomery* 446 (OAC) (determined by W.H. Wagner, Jr. as *Botrychium oneidense* [Gilbert] House), and a sight record at Dickson Wilderness, by Campbell and Britton, in October 1974, in same habitat as *multifidum* and *dissectum*.

**Botrychium matricariaefolium* A. Braun. Rare; one collection from open knoll in yellow birch – red maple – white cedar swamp near Bamberg, Wellesley

Township, concession VI, *Campbell and Diebolt* 75-88 (CAN, WLU).

**Botrychium multifidum* (Gmelin) Ruprecht. Scarce. Definitely known at four localities only: Strasburg, Kitchener, *Campbell and Britton* 70-168 (WLU) and *Campbell and Bald* 73-11 (CAN); Salisbury Drive (west of Victoria Park), Cambridge (Galt), *Campbell and Campbell* 75-76 (WLU); also seen at Dickson Wilderness, Campbell and Britton, November 1975. On edges of sandy, deciduous white pine woods, plants not robust. Collected by Montgomery, 1939, as *Botrychium obliquum* (*Montgomery* 446, HAM) at Kitchener.

Botrychium simplex E. Hitchcock. Rare. One location, Dickson's Woods, Galt, open grassy place, *Prescott* in 1889 (OAC Acc. No. 208) and thicket in edge of swamp, Salisbury Road west of Dickson's Woods, Cambridge (Galt), *Campbell* (3) (WLU). On a sheet at QK (Acc. No. 00519), *Herriott*, Galt in 1904, there are varieties *simplex*, **laxifolium* Clausen and **tenebrosus* Clausen as determined by Britton and Campbell 1973.

Botrychium virginianum Swartz. Common.

Osmundaceae

Osmundae cinnamomea L. Frequent.

**Osmunda claytoniana* L. *Herriott* (without date) lists this species as "frequent". No *Herriott* specimens have, however, been located. Occasional, edges of swamps and low woods and bases of slopes, e.g., Paradise Lake, Sudden Tract (Causeway Swamp), northwest of Galt "Footbridge," Dryden Tract (Alps Road); Dickson Wilderness, Brachton and University of Waterloo campus (seven locations).

Osmunda regalis L. var. *spectabilis* (Willdenow) Gray. Frequent.

Adiantaceae

Pellaea glabella Mettenius var. *glabella*. Rare. Known only from dolomitic cliffs on both banks of the Grand River between Galt and Preston (Cambridge); abundant on some cliffs. Collected here as early as 1893 by *Herriott* and intermittently to the present. Early collections were identified as *Pellaea atropurpurea* (L.) Link, a triploid, but are referable to *Pellaea glabella*, a tetraploid which is glabrous. A recent voucher: *Campbell and Reznicek* 71-95 (OAC).

Adiantum pedatum L. Frequent.

Polypodiaceae

Polypodium virginianum L. Scarce. Collected at three sites. On dolomitic outcrops at the rifle range north of Galt, *Herriott*, August 13, 1892 (OAC) and Wilke's estate (Cruickston Farm), *Campbell and Schaefer* 70-173 (WLU); and on tree roots, Northeast Woolwich

Swamp, *Campbell and Lamb* 24 May 1969 (WLU). Sight records: Doon Pioneer Village (*Campbell circa* 1964); Grass lake (Paris Cranberry Bog), Macdonald, International Biological Program Survey, on logs and wooded banks, respectively; also, at Josephburg and Erbsville (Diebolt; *Lamb* 15, 1976, large colony on root mass). Our plants are sexual tetraploids ($n = 74$)

Dennstaedtiaceae

Dennstaedtia punctilobula (Michaux) Moore. Scarce, collected at three localities in mixed and deciduous woods. Four mi (6.4 km) southwest of Kitchener, *Montgomery* 774 (OAC) and 1½ mi (2.4 km) below #7 Highway near Petersburg, *Montgomery* 774 (TRT), are presumably the same site; Doon Pioneer Village, Kitchener, *Campbell and Bald* 73-14 (CAN); Schaefer's Woods, Erbsville, *Campbell* 75-135 (WLU).

Pteridium aquilinum (L.) Kuhn var. *latiusculum* (Desvaux) Underwood ex Heller. Common.

Thelypteridaceae

Thelypteris noveboracensis (L.) Nieuwland (as *Dryopteris* in Gray's Manual, Fernald (1950)). Occasional, collected at eight localities: e.g., Branchton West, *Herriott*, 20 September, 1902 (OAC), Pioneer Village Woods, *Campbell*, 11 June, 1964 (WLU), Erbsville, *Wellwood* 312 (WLU).

Thelypteris palustris Schott var. *pubescens* Fernald (as *Dryopteris thelypteris* (L.) Gray in Gray's Manual (Fernald 1950)). Common.

**Phegopteris connectilis* (Michaux) Watt (as *Dryopteris phegopteris* (L.) Christensen in Gray's Manual, Fernald (1950)). Scarce, collected at four localities, in or along swamps under beech or cedar, few; Wilke's estate, *Herriott* (OAC 1939), Paradise Lake, *Montgomery* 1029 (OAC), Roseville Swamp, *Campbell s. n.* 27 July 1969 (WLU), and Schaefer's Woods, Erbsville, *Campbell et al.* 75-123 (WLU).

Aspleniaceae

**Asplenium platyneuron* (L.) Oakes. Rare, in Dryden Tract (Alps Road), North Dumfries Township; small widely-scattered colony growing on moist sand in pine reforestation; photographed here in September 1975; substantiating earlier report of Diebolt and Donaldson for 8 July 1975 in the Waterloo Region Annotated Plant Species List, 1976, Man-Environment Studies, University of Waterloo. A second colony was found in the Sandy Hills Tract, (North) Woolwich Township: eight young plants on shady, mossy ridge of sandy loam in maturing red pine and spruce plantation, found by G. Francis, 21 May 1977, *Campbell* 77-41 (CAN, WLU).

Asplenium trichomanes L. Rare, well-known from

exposed dolomitic outcrops of Cruickston Park Farm (Wilke's) along Grand River, and opposite in City of Cambridge (Preston); *Herriott*, 1895 (OAC, 170), *Montgomery and Campbell s. n.*, 2 November 1968 (WLU). Our collections are tetraploid ($n = 72$).

Camptosorus rhizophyllus (L.) Link. Known from the collections of *Herriott*, in 1893 (OAC) and *McGill* (without date and detailed locality), QK. Considered extinct by *Montgomery* (1945). *Herriott's* locality was "the rifle-range, Galt," which now is sparsely shaded and appears too dry to support this species. Thorough searches have been made for it.

Matteuccia pensylvanica (Willdenow) Morton (as *Pteritis nodulosa* (Michaux) Nieuwland in *Montgomery* (1945)). Common.

Onoclea sensibilis L. Common.

Athyrium filix-femina (L.) Roth (as *Athyrium angustum* [Willdenow] Presl in *Montgomery* (1945)).

**Athyrium pycnocarpon* (Sprengel) Tidestrom. Scarce, collected at five localities where it occurs sparsely in rich moist seepage areas in hardwoods: Wilke's estate, *J. Kerr*, 1904 (OAC); 1 mi (1.6 km) south of Galt, *Cruise* 8602, 8 September 1956 (TRT, OAC, UWO); Waterloo (Rummelhardt), *Kott and Kott*, 15 August 1972 (WLU); Bamberg, *Diebolt and Campbell* 75-87 (2), 14 September 1975 (WLU, CAN); Schaefer's Woods, Erbsville, *Campbell* 75-136, 5 October 1975 (CAN, WLU); and *McGill* (QK) without date or detailed locality. Also, sight records are known for the St. Agatha, West Montrose, and Kitchener areas (Brown 1975; MacDonald 1970; Shantz *circa* 1962).

Athyrium thelypteroides (Michaux) Desvaux. Occasional. In rich, moist deciduous woods on seepage banks and in glades: for example, Galt, *Herriott*, 10 July 1894 (OAC); Sugar Bush Park, Waterloo, *Campbell s. n.*, June 1968 (WLU); north of West Montrose, *Britton et al. s. n.*, 26 July 1972 (OAC).

Gymnocarpium dryopteris (L.) Newman (*Dryopteris linnaeana* Christensen in *Montgomery* (1945) and *Dryopteris disjuncta* Morton in Fernald (1950)). Occasional in cedar swamps and low woods under conifers: for example, Paradise Lake, *Britton et al.* 2658, 26 July 1972 (OAC); Preston, *Lewis, s. n.*, 22 June 1936 (TRT).

Cystopteris bulbifera (L.) Bernhardt. Frequent.

Cystopteris fragilis (L.) Bernhardt. Occasional. Usually on moist, shady banks or sandy ridges: for example, Spongy Lake, *Wellwood* 2104, (WLU); Alps Woods, *Wellwood* 731 (WLU); Ayr Road, *Adams* 249 (WAT). All specimens we have seen for the region are referable to variety *mackayi* Lawson. *Adams* 249, although very large and growing on soil, has spores conforming in size to tetraploid *C. fragilis*, not to

those of *C. protrusa* Blasdel, a diploid.

Polystichum acrostichoides (Michaux) Schott. Common.

Dryopteris clintoniana (D. C. Eaton) Dowell (*Dryopteris cristata* var. *clintoniana* Underwood in Montgomery (1945) and Fernald (1950)). Frequent, sometimes numerous, in rich, springy ground or on rotten logs and bases of dead trees. Found in diverse habitats from deciduous woods to glades in white spruce-cedar swamps. A cytological voucher ($n = 123$) from Altrieve Lake, North Dumfries Township, Britton B534 (OAC).

Dryopteris cristata (L.) A. Gray. Occasional. A cytological voucher from Altrieve Lake bog, Britton 528 (OAC) ($n = 82$).

Dryopteris goldiana (Hooker) A. Gray. Rare, known only from two localities: one extant colony: "Rummelhardt" near Erbsville, small patch in rich deciduous woodlot near intermittent stream, Wellwood 2129 (WLU). The stand in the swamp at back of Dickson's Woods (Victoria Park), Cambridge (Galt), Herriott in 1902 (OAC) has not been relocated despite repeated search. A sheet at QK (Acc. No. 50928) collected by D. H. McGill without date or locality except "Waterloo County" is this species.

Dryopteris intermedia (Willdenow) A. Gray (*Dryopteris spinulosa* var. *intermedia* Underwood in Montgomery (1945) and Fernald (1950)). Frequent, in mixed or rich deciduous woods, for example, Glasgow Woods, golf course, Kitchener, Campbell 73-47B and "Rummelhardt," Waterloo, Campbell and R. Britton 72-22, and Schaefer's Woods, Erbsville, Campbell 75-137 (all WLU).

Dryopteris marginalis (L.) A. Gray. Occasional.

Dryopteris spinulosa (O. F. Mueller) Watt (*Dryopteris carthusiana* (Villars) H. P. Fuchs). Montgomery (1944) and the Waterloo Region Annotated Plant Species List (1976) provide numerous records. Montgomery (1944) cites a specimen of Herriott (OAC 210) as *Dryopteris spinulosa* var. *americana* (Fischer) Fernald. This taxon is now considered as comprising two sexual species, *Dryopteris assimilis* S. Walker, a diploid, presently not known from nearer than eastern Lake Superior, and *Dryopteris campyloptera* (Kunze) Clarkson, essentially an Appalachian species still unconfirmed for Ontario. The Herriott sheet (OAC 210) is comprised of two taxa: one frond of *Dryopteris intermedia* and a portion of a frond *Dryopteris* \times *triploidea* Wherry.

Hybrids

Dryopteris clintoniana \times *cristata*. Apparently rare, collected only at Altrieve Lake, with parents, low wet swamp, Britton 532 and 533 (OAC), the latter a cyto-

logical voucher (82 II, 41 I) (Widen and Britton 1971).

**Dryopteris clintoniana* \times *intermedia* (*Dryopteris* \times *dowellii* Wherry). Occasional, collected at six sites in company of parents, e.g., springy ground and swamp edges and glades, Strasburg Road, Kitchener, Campbell and R. Britton 72-5 (WLU), Homer Watson Park, Kitchener, Campbell and R. Britton s. n. (WLU 9596), Beake Pond, R. Britton 6 September 1972 (WLU).

**Dryopteris clintoniana* \times *marginalis* (*Dryopteris* \times *burgessii* Boivin). Scarce, collected in Roseville Swamp in hemlock-yellow birch stand, Britton 2518 (OAC), Wilmot Center, Wilmot Township, boggy swamp edge, Campbell 72-27 (CAN, OAC) and Homer Watson Park, Kitchener, Campbell and Schaefer 75-46 (OAC). Rarely collected (Wherry 1961).

Dryopteris cristata \times *intermedia* (*Dryopteris* \times *bootii* [Tuckerman] Underwood). Occasional with parents in swamps and moist woods: Altrieve Lake, Britton B536 (OAC), a cytological voucher ($2n = 123$), Northeast Woolwich Swamp, Britton and Campbell 2239 (OAC), Beake Pond, Campbell et al. 74-301 (OAC), Homer Watson Park, Kitchener, Campbell and Schaefer 74-249a (WLU) are representative collections (Widen and Britton 1971).

**Dryopteris cristata* \times *marginalis* (*Dryopteris* \times *slossonae* Wherry). Rare, collected only once, in muck among cedars, Doon Pioneer Village, Kitchener, Campbell and Bald 73-13 (WLU).

Dryopteris cristata \times *spinulosa* (*Dryopteris* \times *uliginosa* Druce). Rare, collected twice, in swamps with parents, Beake Pond, R. Britton 6 September 1972 (WLU) and Altrieve Lake, Britton 535 (OAC) (Widen and Britton 1971).

**Dryopteris intermedia* \times *spinulosa* (*Dryopteris* \times *triploidea* Wherry). Frequent.

**Dryopteris marginalis* \times *spinulosa* (*Dryopteris* \times *pittsfordensis* Slosson). Rare, collected once, to north of Dickson Wilderness, North Dumfries Township, Campbell s. n., 4 October 1970 (WLU).

Blechnaceae

**Woodwardia virginica* (L.) J. E. Smith. Rare, known only from the remnants of a large peat bog (now Idlewood Park), Kitchener: R. Britton and Campbell 72-34, 15 August 1972 (WLU, CAN, OAC). Discovered here by V. Shantz circa 1971. Very scattered across southern Ontario, limited to certain bogs; mapped by Cody (1963). (A report from Beverly Swamp in the Waterloo Region Annotated Plant Species List (1976) may refer to Wentworth Region; there is no known specimen for the Waterloo portion of the Swamp.)

Exclusions

Equisetum palustre L. Although reported in the Waterloo Region Annotated Plant Species List (1976), from three localities in the region, no specimens can be located. The species should be present.

Phegopteris hexagonoptera (Michaux) Fée. This species has not been found in the region, although it is well known from Pinehurst Park and Spottiswood Lake just south of the regional boundary in Brant County. The specimen at QK (Herriott, 17 September 1904) is a duplicate of Herriott's sheet in OAC, but is missing the detailed locality datum which was "Spottiswood Lake." The species should be present in the region.

Polystichum braunii (Spencer) Fée. A "Waterloo County" collection by McGill, "July" (1913 added by someone else) is in QK (Acc. No. 50904). This northern fern has its nearest known definite locality at Nestleton Station, Durham County (Taylor 1934); its occurrence in Waterloo region seems unlikely.

Polystichum lonchitis (L.) Roth. Reported by Montgomery (1944) as having been collected by Herriott at the "footbridge below Galt," 13 July 1892; the specimen has not been seen by the authors, and its whereabouts is not known. Very little suitable habitat seems to exist at this site today.

Discussion

This paper brings to 68 the taxa of pteridophytes definitely known from the Waterloo region. Eleven of these are hybrids (three *Equisetum*, eight *Dryopteris*) and six are often considered as varieties, or well-marked forms, hence 51 are species. (Another four taxa are here excluded from the regional flora.) Of these 51 species, 11(*) are herein reported for the first time for the Waterloo region; in addition, 13 varieties, forms, and hybrids are reported for the region for the first time. (See footnote on page 3.)

This list of pteridophytes has more taxa than lists for neighboring counties do. Although no complete lists as yet exist for Perth, Oxford, Brant, or Wentworth Counties, Britton has records for 47 species from Wellington County and Cruise (1969) lists 45 native species for Norfolk County.

In the Waterloo region, 10 species of club mosses and ferns are rare and known at only one or two stations, whereas only seven are common. Seven hybrids are also considered rare at

present, but may be overlooked at other sites. One species, the Walking Fern (*Camptosorus rhizophyllus*) appears to be extinct in the region; also, the Adder's Tongue (*Ophioglossum vulgatum*) has not been recorded recently.

Recent designation (1976) of environmentally sensitive areas within the region may provide some protection for a number of stations of rare pteridophytes. One of the plants listed for Ontario as rare by Argus and White in a mimeo list from the National Museum is the Narrow-leaved Spleenwort (*Athyrium pycnocarpon*); it is now recorded from eight locations in the Waterloo region but very few living vigorous clones exist. A number of the species, herein listed as rare regionally, might also be considered endangered. Although *Dryopteris goldiana* has decreased within the region, and the holly ferns (*Polystichum lochitis* and *Polystichum braunii*), if they actually occurred here, may be extinct, several pteridophytes may be increasing. Abandoned gravel pits seem to provide habitats for new stations of *Equisetum variegatum* and *Equisetum laevigatum*. Possibly the grazing of many woodlots as well as walking trails through them has provided suitable ecological niches for colonies of botrychiums. Also, Britton believes that the Ebony Spleenwort, *Asplenium platyneuron* is increasing in southern Ontario, which may account for our recent addition of it to the Waterloo flora. *Dryopteris clintoniana* and *Dryopteris* hybrids undoubtedly have not increased, but because of particular attention paid to this genus, have been found more often.

Despite some searching for them, nine species which are to be expected in the region have not been found yet. In addition to the two in the excluded list, they are: *Lycopodium tristachyum*, *Selaginella rupestris* (both on sand), *Botrychium lanceolatum*, and *Botrychium ternatum*; *Cryptogramma stelleri*, *Asplenium viride*, and *Pellaea atropurpurea* (which all might conceivably be on the cliffs at Cruickston Farm). The hybrid horsetail *Equisetum* × *litorale* (*Equisetum fluviatile* × *Equisetum arvense*) likely occurs in the Waterloo region, as well as some other hybrid pteridophytes, especially in *Dryopteris*.

The diversity of habitats within the Regional Municipality of Waterloo surely contributes to

the relatively rich (for southwestern Ontario) pteridophyte flora. Numerous swamps and bogs, as well as many rich woods, provide a range of acidic to neutral soils. Rock outcrops are few, as are sandy tracts, but both contribute a few notable species such as *Equisetum laevigatum* and *Asplenium trichomanes*.

Closely associated with limestone (dolomitic) rock in the region are *Pellaea glabella*, *Polypodium virginianum*, *Asplenium trichomanes*, and *Camptosorus rhizophyllus*. Boreal species associated with bogs and cool swamps are *Equisetum pratense*, *Equisetum scirpoides*, and *Equisetum sylvaticum*; *Lycopodium annotinum*, *Lycopodium clavatum*, *Lycopodium inundatum*, *Lycopodium lucidulum*, and *Lycopodium obscurum*; also, *Phegopteris connectilis* (after Thaler and Plowright 1973). A species of northern Appalachian affinity is *Dryopteris goldiana*. *Woodwardia virginica* is a fern with Atlantic coastal plain affinities (Cody 1963). These local pteridophytes which may be considered essentially southern are *Equisetum laevigatum*, *Selaginella apoda*, (*Phegopteris hexagonoptera* — a species excluded from the Waterloo list), *Athyrium pycnocarpon*, and *Asplenium platyneuron*.

Thus in its pteridophyte flora as in its other floristic origins, the Waterloo region exhibits an overlap between northern and southern plants.

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The Biological Flora of Canada — A New Series

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Abstract. *The Canadian Field-Naturalist* will publish a continuing series of papers on the biology and ecological life history of vascular plant species native or well naturalized in the flora of Canada. This paper sets forth the guidelines and format for contributing authors. The new Canadian series is patterned after the *Biological Flora of the British Isles*, a continuing series published in the *Journal of Ecology*.

Notice to Contributors

The *Canadian Field-Naturalist* has agreed to publish a continuing series of papers on the biology and ecological life history of vascular plant species that are native or well naturalized in the flora of Canada. These accounts will be written by various authors, follow approved guidelines and format (see below), conform to the standards and style of this journal, and include distribution maps, literature citations, and other information needed to describe and interpret the role of the species in the vegetation of northern North America. This is usually best achieved by a synthesis of information obtained from the literature together with original research on aspects not previously investigated. The accounts will be numbered and appear in order of acceptance, with a maximum of two published per issue.

A similar project, *The Biological Flora of the British Isles*, was undertaken by the British Ecological Society in 1945 and has been a regular feature of *The Journal of Ecology* ever since (British Ecological Society 1975). Recently the *Canadian Journal of Plant Science* has initiated a series on *The Biology of Canadian Weeds* (Cavers and Mulligan 1972) and one on *The Biological Flora of the Canadian Prairie Provinces* (Looman 1973). Species already registered, or previously published, or more appropriately published in the latter two series will not be registered for publication in our series; close liaison is maintained between editors of the two journals to insure that the same species is not registered in more than one series.

Inquiries about the series and offers of contributions should be made to the author; the latter are subject to approval by a committee of botanical associate editors. Finished manuscripts may not exceed 10 journal pages, including text, tables, and illustrations; they should be submitted to the Editor.

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Only papers on vascular plants will be accepted, including aquatic, wetland, and terrestrial species; this restriction will be reviewed periodically. Very closely related species may be treated together in some cases. Both native and very well naturalized species are eligible. Species already treated in the *Biological Flora of the British Isles* (British Ecological Society 1975), *Silvics of Forest Trees of the United States* (Fowells 1965), and equivalent references will be registered, written and published as "Supplementary Accounts" to avoid needless replication.

Decisions on acceptance of a particular species will be influenced by (a) its ecological and economic importance in Canada, (b) extent of its total range in Canada, e.g., species reaching their northern limits in the extreme south of Canada will receive lower priority. Acceptance of offers and acceptance of manuscripts are entirely separate matters. Poorly known species should not be offered unless the contributor is able and willing to obtain the substantive information specified in the schedule below.

Contributors will be allowed to register only two species in our list of species in preparation, as single or multiple authors. Approved offers will be registered for three years, after which reapproval must be sought or the species will be deleted from the list and made available to other potential

contributors. An approved blank base map will be provided to approved contributors; it will cover all of Alaska, Canada, Greenland, St. Pierre and Miquelon, and the northern fringe of the conterminous United States. Contributors must consult with and acknowledge the Herbaria of the Canada Department of Agriculture and the National Museum of Canada in Ottawa regarding loans of specimens and use of their facilities for checking determinations of specimens and plotting distributions of species on dot maps. Subsequent papers reporting significant range corrections and extensions, and submitted to this journal, should employ the same map and clearly depict the changes.

Schedule for Contributors (1977)

1. *Name*.¹ The scientific name (genus, species, authority) currently accepted, followed by the subgenus or section, and family. No more than three of the most important synonyms. English and French vernacular names most commonly used in Canada.
2. *Description of the Mature Plant*. Concise description of the adult sporophyte, with attention to (a) *Raunkiaer life-form* and perennation, (b) *Shoot morphology*, i.e., above-ground vegetative structures, (c) *Root morphology*, i.e., below-ground structures, (d) *Inflorescence*. Include diagnostic and important characters. Important infraspecific morphological variation within the region including (e) *Subspecies*, (f) *Varieties* (g) *Ecotypes*, (h) *Chromosome number(s)* of species together with locality and authority. Photographs and well-executed drawing of typical living and mounted herbarium specimens.
3. *Distribution and Abundance*. Native or introduced since European settlement, with notes on first records, rate of migration, and stability of present distribution. (a) *Geographic range* of species and its major variants in region from herbarium records confirmed by the author(s) and plotted on a standard base map to be provided; notes on abundance in region; maps and notes on distribution outside the region in less detail; cite published distribution maps. (b) *Altitudinal range* in and outside region; notes on abundance and infraspecific variation in relation to elevation.
4. *Physical Habitat*. (a) *Climatic relations* in general, then specific ranges and optima for temperature, precipitation, humidity, light, wind, etc., with attention to seasonal variations of these in relation to the life cycle and phenology of the plant. (b) *Physiographic relations*, including slope and exposure, ranges of geologic parent materials, soil types, drainage classes and moisture regimes; soil terminology should conform to the current edition of *The System of Soil Classification for Canada* (Canada Department of Agriculture 1974). (c) *Nutrient and water relations*, including general requirements, performance in specific nutrient and moisture regimes, and the plant's role in the total nutrient and water balances of the ecosystem. Emphasize specific factors that exert primary control on distribution and abundance in the region.
5. *Plant Communities*. General summary of plant community types in which the species occurs in the region, with notes on local distribution, abundance, and reproductive success in them. A species-stand table showing the physiognomy and floristic composition of a representative spectrum of community types in which the species is an important component and/or grows well. Cite publications containing community descriptions and tabulations which include the species.
6. *Growth and Development*. Concise description of plant growth and development from germination through maturity to senescence and death. (a) *Morphology* of plant at critical developmental and phenological stages depicted in well-executed drawings, with notes on morphological adaptations, rates of growth, and duration of stages. (b) *Physiology* of plant at critical developmental and phenological stages depicted in tables giving the rates of vital processes (photosynthesis, respiration, translocation, transpiration) and normal physiological states (leaf water potential, biochemical composition) under specified conditions of light, moisture, nutrients,

¹Each account will be given a serial number when accepted for publication.

and temperature. (c) *Phenology* of species at different localities within region including dates of germination; onset of vegetative growth, flowering; maturation and dispersal of seeds; peak root and shoot growth; return to dormant state above and below ground.

7. *Reproduction*. (a) *Floral biology* of the plant including mode of pollination; incidence of autogamy, allogamy, agamospermy, vivipary. (b) *Seed production and dispersal*, including data on age-specific numbers of seed per fruit and per plant; modes of dispersal and their effectiveness; seed production in relation to geographic location, habitat quality, year. (c) *Seed viability and germination* under different conditions, with notes on the nature of dormancy and conditions necessary for maintaining or breaking it; specify methods of seed collection, storage, and treatment as well as germination conditions. (d) *Vegetative reproduction* mode(s) and rates in relation to geographic location, habitat quality, age of plant; importance compared to sexual reproduction.

8. *Population Structure and Dynamics*. (a) *Dispersion patterns* at different stages in the life cycle and in different habitats. (b) *Age distribution*, age-specific mortality rates, and longevity in different habitats, with notes on causes of mortality. (c) *Size distribution* of individuals in populations of different habitats, with data on correlations between age and size of individuals. (d) *Growth and turnover rates* of stable and unstable populations in different habitats, expressed as percentage increase, decrease and replacement of population (density, biomass, etc.) per year. (e) *Successional role* of species in relation to geographic location, habitat quality, type of disturbance, severity of disturbance.

9. *Interaction with Other Species*. Concise description of (a) *Competition* with commonly associated plant species for light, nutrients, water and space; (b) *Symbiosis* with other organisms; list important pollinators, endophytic nitrogen-fixing bacteria, mycorrhizal species; (c) *Predation and parasitism* with other organisms; list host species if the plant is parasitic; list important animal and fungal predators and parasites, and bacteria and virus disease organisms for which the plant is prey or host, the parts and/or life cycle stages used by them, their effects and symptoms, and their geographic distribution and abundance in relation to those of the plant; (d) *Toxicity and allelopathy* to other organisms; list substances and their effects on other species.

10. *Evolution and Migration*. A brief account of the origin and phylogeny of the species, and its history as a member of the Canadian flora. Notes on fossil records, glacial refugia, migrational patterns, etc. If introduced since European settlement, provide relevant details in (3). Chemotaxonomic, cytotoxic and other supporting evidence may be cited here. Occurrence and frequency of hybrids with other species, how they may be recognized, and where they may be found.

11. *Response Behavior*. Normal responses of individuals and populations to (a) *Fire*, (b) *Grazing and harvesting*, (c) *Flooding*, (d) *Drought*, (e) *Herbicides*, (f) *Chemical changes* including toxic compounds and nutrient levels, (g) *Other factors*. Significant adaptations should be noted.

12. *Relationship to Man*. Concise summary of the plant's importance to man, as a crop, pest, or reclamation species, etc., in the past and present in the region. Man's influence on the distribution and abundance of the species in the region.

13. *Special Features*. Noteworthy information not provided for elsewhere in the schedule.

Acknowledgments

The author thanks G. W. Argus, C. D. Bird, W. J. Cody, and L. C. Smith for their suggestions and constructive criticisms of the guidelines and schedule.

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Movements and Habitat Use among Interacting *Peromyscus leucopus* as Revealed by Radiotelemetry

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Abstract. Radiotelemetry and trapping methods were used in a systematic effort to record habitat use, home range size, and social interactions in a free-ranging population of *Peromyscus leucopus*. A total of 64 mice were censused in an isolated 2.3-ha woodlot in May and June 1975, revealing a large spring density of 21.7 resident mice/ha. The sex ratio in each age class was approximately 1:1. The subadult age class had significantly more transient individuals than did the juvenile or adult age classes. From the 36 adults captured in traps, nine males and six females were followed using radiotelemetry during an 8-day period. These mice were located once day and night for a total of 124 detections. Daytime refuges were usually in groundhog (*Marmota monax*) burrows and rock piles, and were similar for both sexes. Nocturnal activity was at ground level, with the males showing a significant tendency to occupy the surrounding fields instead of the woodlands. The occupation of defecation chambers in the groundhog burrows and the caching of large fecal pellets in other refuges suggested interspecific coprophagy. The large number of hickory nuts and nut fragments in the refuges suggested abundant food supplies during the winter. A large winter food supply together with the abundant rock piles and groundhog burrows probably accounts for the large spring density in the population studied. Home range size (minimum area method) was similar for both sexes, averaging 0.1 ha. Sustained social contact was frequent between adult male and female voles, whereas low levels of contact occurred between adults of the same sex, and then only between males. These data support the potential of radiotelemetry to supply important biological information on the movements of free-ranging rodents.

Key words: *Peromyscus*, habitat, movements, radiotelemetry, spacing, nests

Rodent studies have been of central importance to the formulation of many ecological principles. Yet little direct information is available on daily activities and resource use in free-ranging rodent populations, even in such a widely studied species as *Peromyscus leucopus* (Metzgar 1971; Myton 1974; Terman 1968). Historically, methods involving trapping, photographic, and smoked-paper techniques have limited attention to positions in space or time selected by the experimenter, not by the animal. More recent rodent studies involving radiotelemetry (Banks et al. 1975; Brooks and Banks 1971; Chute et al. 1974; Madison 1977; Mineau and Madison 1977; Shields 1976) or radioisotope tracking (Ambrose 1969, 1973; Graham 1968) are beginning to yield direct information on natural patterns of movement. A study such as that of Banks et al. (1975) involving the simultaneous tracking of a large number of free-ranging individuals is important since it provides accurate information on both individual and group (population) responses to environmental and social variables on a daily basis. The following study applies simultaneous radio-tracking procedures in a study of the movements and habitat use of free-ranging *P. leucopus*, a small, highly mobile rodent species.

Methods

Study Area

The study took place in an isolated 2.3-ha (5.3-acre) deciduous woodland near Front Royal, Virginia in 1975. The surrounding land was either alfalfa, hay, or early seral, secondary succession fields. The nearest point to another section of woodland was approximately 250 m north and east of the study woods. The woodlot had a dense stand of hickory (*Carya* sp.) and a large variety of oaks (*Quercus* spp.). The area was browsed by deer as could be noticed by the reduced vegetation near ground level. On several occasions, deer were actually observed in the study area at night. The area was also extensively used by groundhogs (*Marmota monax*); 13 burrow systems with a total of 36 entrances were counted within the study area. Most of these systems were active. Six rockpiles were distributed toward the periphery of the study area, ranging in size from 0.5 m high \times 2 m in diameter to 1.5 m high \times 3 m wide \times 10 m long. These were probably created when the adjacent fields were cleared for cultivation. Grass and succulent broadleaf vegetation invaded the woods 30 m on the northwestern edge of the woodland, but otherwise stopped abruptly at the woods' edge. There was a fairly regular incline of

20 degrees from southeast to northwest through the area.

Trapping Techniques

On 21 May, trapping was initiated using 21 Longworth live traps, both to census the population and to provide individuals for radiotracking. Three trap lines were established about 40 m apart, with the distance between traps in each line averaging 25 m. The traps were supplied with rolled oats for bait and a paper towel for bedding. The traps were set before dark, checked around 2200 hours, reset, and then checked around 0100 hours. This procedure continued until essentially all the adult mice were marked (4 June). Then radiotracking began and only the 2200-hours trap check was made every other day until 20 June when the study was terminated. Six additional traps were added after 10 June to facilitate the recapture of mice with transmitters.

Upon initial capture, each animal was weighed, given a unique toe clip combination, checked for sex and reproductive condition, and then released. During subsequent captures, the procedure was repeated except for toe-clipping. Dramatic weight loss in the females was used as an index of parturition (four females in this study lost from 7 to 10 g between successive trap checks).

Radiotelemetry Techniques

All the adult mice (20 g or more) captured from 2 to 4 June were given transmitters and then tracked concurrently. Conventional radiotelemetry equipment was used (AVM Instrument Co., Champaign, Illinois), including SM-1 radiotransmitters with internal antennae, multiple channel LA-12 radioreceivers, and handheld 4-element Yagi antennae. Details on the radiotelemetry equipment and collar attachment are available in Mineau and Madison (1977).

The positions of the mice were determined by a single observer. During the day the mice occupied nests and therefore could be approached directly to obtain a position. At night, a 6-volt head lamp and a more cautious method of approach were used. Typically, the area to be searched was scanned with the receiving antenna from about 30-40 m distance to assess the different mice present. Then the nearest mouse

was approached, first tangentially to obtain a rough "triangular" fix, then more directly to within about 10 m. At this distance, the direction of maximum signal intensity was scanned slowly by light. Often the light revealed the animal either moving on the woodland litter or perched on some surface object. A coded marker was attached nearby, and the position was described in a notebook in full. In cases where two signals were in close proximity, the observer constantly switched between the frequencies during the approach to assess carefully the proximity of the animals to each other. There was little evidence that the mice were fleeing from the observer. Rather, immobility or slow "foraging" movements were typical.

Radiotelemetry positions were recorded at least once both day and night, thus obtaining one measure of nest location and usually one of surface activity each 24-h period. Transmitter signals at night from day nest positions usually indicated the loss of transmitter collars, except in the case of females tending litters. If a transmitter was no longer on an animal, the transmitter (usually in a nest) was retrieved and the nest was examined.

During the study, many transmitters stopped functioning. The problem was that conspecifics gnawed through the epoxy coating of the transmitter, often destroying the transmitters. That mutual grooming, and not self-grooming, was responsible for transmitter and collar damage was verified in cage studies where only those mice housed together showed such damage. These problems could have been avoided, if anticipated, by using dental acrylic instead of epoxy, and by substituting a different collar material for the cloth used. This damage was not encountered in extensive studies on *Microtus pennsylvanicus* (Madison, unpublished) and on a low-density population of *P. leucopus* (Mineau and Madison 1977). According to the importance of mutual grooming in mating and in the establishment and maintenance of dominance relationships in *Peromyscus* (Eisenberg 1968), transmitter-collar damage is not very surprising. Because sustained proximity and gnawing is required to damage the transmitters, and because overt aggressive actions would presumably result in one mouse

fleeing from the other, social interaction was considered to have been measured.

Data Analysis

All the information from trapping and radiotelemetry will be used during the analysis, but two clarifications are necessary. First, unless stated otherwise, only the mice captured and determined to be "residents" (see "Population structure") will be considered in the analysis. Second, although 19 mice were given transmitters, four were never located using radiotelemetry. Three of these were eventually recaptured without transmitter collars. Of the 15 mice actually monitored, two were tracked only for the first day before their transmitters were damaged. The remaining 13 were tracked both day and night. Thus, the radiotelemetry analyses include either 13 or 15 individuals, as is relevant to the specific analysis.

Population structure. In the population studied, the age class criteria of Bendell (1959) and Snyder (1956) were used. Residency was assumed for a mouse if it was captured 2 or more times over at least a 4-day period. All other mice were considered transients. The 4-day criterion was necessary to distinguish between a resident, who is captured only a few times over a long time interval because of a small or peripheral home range, and a transient, who may also be captured a few times, but only in close succession while passing through the study area. The relative numbers of transient and resident mice in the different age classes were compared using the Fisher exact test (Sokal and Rohlf 1969). This test gives exact probabilities and is particularly useful for small sample sizes and small expected frequencies under the null hypothesis.

Resource use. Data on shelter and food use were collected from the observations on the adult mice that were monitored using radiotelemetry. The day shelters or refuges were classified as either a small ground burrow (mouse-sized or chipmunk-sized entrance), a groundhog burrow, a rock pile, or a tree. Differences in shelter or refuge use between the sexes for the day and night positions were analyzed using Fisher's exact test (Sokal and Rohlf 1969). The utilization of certain foods was estimated from the contents of day nests.

Home range size. Home range size was determined only for the adult mice that were radio-tracked. For the estimates, the trap locations and radiotelemetry positions were enclosed within a peripheral line (minimum area method). Each trap location is arbitrarily considered to be a circle with a 3-m radius, instead of a radius one-half the distance to the nearest trap as in the boundary strip method. This 3-m distance was chosen because of the variable distance between traps and because the smallest interval between the 21 traps set was 6 m. No attempt was made to adjust for "unoccupied regions" within the peripheral lines, because the period of study was short and the observed home ranges were relatively compact.

Social interactions. Estimates of social interaction and tolerance were obtained by considering the instances of transmitter-collar damage, double capture, and social encounter and nest cohabitation of mice tracked with radiotelemetry. The double captures in traps represented close following of one mouse by another, because the trip mechanism in each trap had been adjusted for extreme sensitivity. In cases of social intolerance (e.g., one mouse chasing another) it is assumed that the fleeing mouse would not enter a trap as a means of escape. In no case was there any evidence of fighting by the mice captured together.

Results

A total of 63 *P. leucopus* (49 residents) were captured in traps in the study area. The residents were captured on 290 occasions (average of 5.8 captures/mouse). The 15 mice tracked were trapped on 124 occasions, and from the beginning of radiotracking had 64 day and 44 night positions recorded (Table 1). The animals were tracked for an average duration of 5 days each (1 to 8 day range). On only three occasions did we fail to find a mouse whose transmitter, upon subsequent inspection, was known to be functioning. On two of these occasions, which were recorded successively for the same animal, the failure probably resulted from a weak transmitter signal combined with a shift in habitation to a groundhog burrow system.

TABLE 1—Capture, position, and home range data for *Peromyscus leucopus* tracked with radiotelemetry

	Number trap captures	Number traps	Number radio positions	Total number positions	Number days tracked	Home range (acres) ¹
Males (N = 9)						
Mean	7.7	2.2	7.6	15.2	4.8	0.24
SD	3.4	0.7	4.0	2.9	2.1	0.14
Range	3–13	1–3	1–14	12–20	1–8	0.04–0.43
Females (N = 6)						
Mean	9.2	2.8	6.7	15.8	5.0	0.26
SD	5.2	1.8	3.4	7.3	2.3	0.24
Range	2–15	1–5	1–11	3–24	1–7	0.08–0.64

¹The home range calculations for the females are based on N = 5; one female was omitted from the calculations because of inadequate data.

Population Structure

The density of the resident population was 21.3 individuals/ha (8.4 mice/acre). Three different age class modes were observed, one averaging 13 g representing juveniles about 4 weeks of age, a second averaging 16 g representing subadults about 7 weeks of age, and a third around 23 g representing sexually mature adults of a wide age spectrum (Figure 1). The sex ratio for the resident immature mice was approximately 1:1 (8 males, 9 females). The ratio for the adult residents was similar (17 males, 15 females). Transient status was recorded for 2 of 13 juveniles, 8 of 14 subadults, and 4 of 36 adults. The two mice at 14 g were divided among the

juvenile and subadult age groups because of unclear group affiliation. The hypothesis of no difference in the relative numbers of resident and transient mice among the juvenile and subadult age groups is rejected ($P = 0.03$), as is the null hypothesis relative to the subadult and adult age groups ($P < 0.001$). The null hypothesis relative to the juvenile and adult age groups, however, is not rejected. These results indicate more transient mice, and hence a greater degree of either dispersal or death, in the subadult age class.

Habitat Use

Refuge use (rock piles, groundhog burrows) at

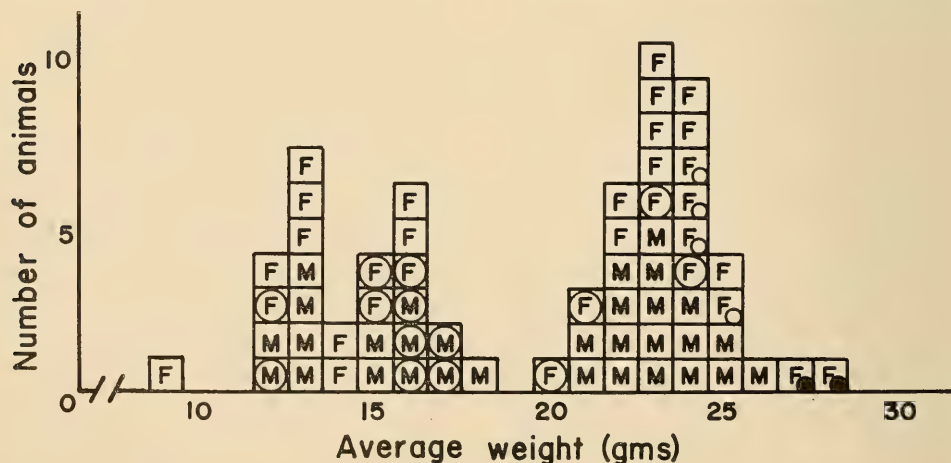


FIGURE 1. Weight frequency distribution of all *Peromyscus leucopus* captured in the study area. Circled F (female) and M (male) indicate transient individuals. Solid dots indicate pregnant females; open dots, females having had a litter within the study period.

TABLE 2—Habitat use during night positions (2100–0400 hours) for 13 *Peromyscus leucopus* tracked using radiotelemetry in June 1975. Number of different occurrences are given. Numbers of different animals appear in parentheses

Sex	Tree			Grass	Leaf litter	Groundhog burrow	Rock pile
	Animal height (m)						
	0–1.4	1.5–2.9	3.0+				
Males 27(8)	2(2)	2(2)	0(0)	13(5)	8(6)	0(0)	2(1)
Females 17(5)	5(4)	1(1)	1(1)	0(0)	5(4)	3(2)	2(1)
Totals		11(7)		13(5)	13(10)	3(2)	4(2)

night occurred on 5 of 17 occasions for females, but only on 2 of 27 occasions for males ($P = 0.06$; Table 2). Nocturnal activity was primarily at ground level (leaf litter, grass, tree bases) for both sexes. During ground level activity, however, the males occupied the grass areas of the surrounding fields on 13 of 23 occasions compared to 0 of 10 occasions for the females. The hypothesis of no relation between the use of the grass fields and the sex of the adult is rejected ($P = 0.002$). These results suggest differences between the sexes in habitat preference and (or) food utilization at night.

Refuge use by the 15 mice tracked during the day consisted primarily of groundhog burrows, with 10 of 15 mice found in these burrows on 34 of 64 occasions (Table 3). Rock piles were preferred next with six mice in these structures on 15 occasions. About 50% (8 of 15) of the mice utilized more than one day refuge during the study. There was no indication of differences in day refuge preference between the sexes.

The utilization of certain foods was suggested from the contents of the six day nests that were excavated to retrieve transmitter collars. Three units were found in the defecation chambers of groundhog burrows. A prominent feature of these chambers was a layering of groundhog feces and leaves with a thickness of 0.2–0.3 m in the chamber floor, giving a compost effect with the associated increase in temperature (the warmer temperature was gauged by touching). The topmost fecal pellets were green as if consisting of semi-digested grass mulch. The possibility of these pellets serving as a supplementary food source is suggested (interspecific coprophagy). In two of these groundhog refuges,

a large cache of nuts, seeds, and shell fragments (e.g., hickory, cherry) were uncovered, but no nest structure was found. Two other transmitters were recovered from a single refuge site in a rock pile. This refuge contained a fur-lined grass nest, a large cache of nut and nut fragments (hickory, cherry, white oak acorns), gnawed twigs (cherry (*Prunus* sp.), birch (*Betula* sp.)), male flower parts from oaks (*Quercus* spp.), legumes, several Coleoptera insect parts, and one area with a concentration of mice feces. Notable among the nest site contents were several bone fragments scarred by *Peromyscus* tooth marks, and two fecal pellets (one a 2-cm-wide \times 1-cm-long segment from a large herbivorous mammal, and one a 0.7-cm-wide \times 3-cm-long scat containing hair and nut fragments from a small carnivore). The sixth transmitter was found in a cavity at the base of a dead cherry tree. A small cache of leaf and nut parts was found, with a nut composition and tooth marks similar to that in the rock pile nest.

TABLE 3—Refuge use during day positions (0700–1900 hours) for 15 *Peromyscus leucopus* tracked using radiotelemetry in June 1975. Number of different occurrences are given. Numbers of different animals appear in parentheses

Sex	Ground-hog burrow	Small ground burrow	Rock pile	Tree
Males 40(9)	23(6)	2(1)	8(4)	7(2)
Females 24(6)	11(4)	4(3)	7(2)	2(2)
Totals	34(10)	6(4)	15(6)	9(4)

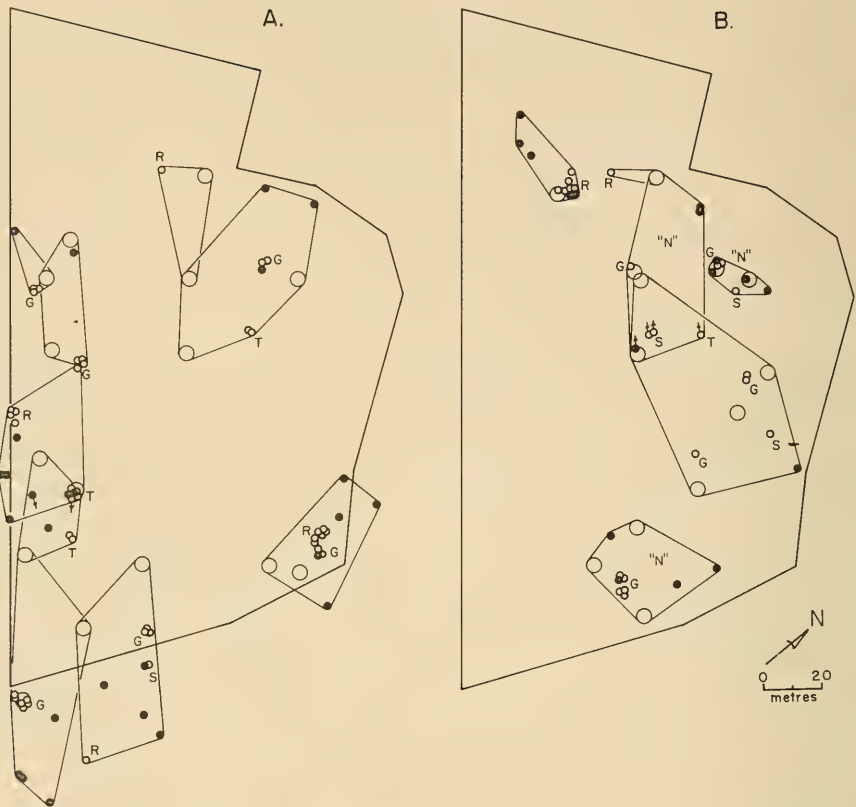


FIGURE 2. Home ranges of all resident adult *P. leucopus* that were radio-tracked. The radiotelemetry positions (small circles; solid = night, open = day) and trap capture positions (large circles) are indicated for the males (A) and females (B). The letters next to the radiotelemetry positions identify refuges in trees (T), groundhog burrows (G), small ground burrows (S), and rock piles (R). The nursing females are indicated by N. The small arrows associated with radiotelemetry positions in areas of home range overlap point to the home range to which the positions belong.

Home Range Size

Male home ranges averaged 0.10 ha (0.24 acre, SD = 0.14 acre) based on 12 to 20 capture and radiotelemetry positions for each animal (Figure 2, Table 1). For the females, an average area of 0.11 ha (0.26 acre, SD = 0.24) was recorded based on 14 to 24 positions per animal. The small difference in home area size between the males and females was not significant. These estimates are independent of "edge" effects since the animals living in the border areas were tracked into adjacent fields.

Social Interaction

There were 15 instances where the fate of the

transmitter and collar was known, with 13 units sustaining damage (86.7%) within 8 days (mode of 4) of the initial collar attachment. Only two mice retained their collars and transmitters throughout the tracking period without damage. These data indicate frequent social interactions of a sustained nature within the population.

The eight instances of double capture also support the occurrence of social interactions within the population (Table 4). Four double captures involved only juveniles. Because of the similarity in weights within each pair, it is suggested that litter mates were travelling together. Two scrotal males were involved in the remaining four double captures. These males

TABLE 4—Instances of double captures of *Peromyscus leucopus* in traps. The weights are those recorded at time of double capture

Date	Animals captured together			
	Sex	Weight (g)	Sex	Weight (g)
1 June	M _s	22	F _l	25
2 June	same		M _{ns}	23
3 June	M _s	23	F	20
10 June	same		M	16
26 May	M	15	M	13
10 June	F	9	M	10
17 June	F	13	F	15
20 June	F	14	F	15

s = scrotal; ns = nonscrotal; l = litter

had lost their transmitter collars on the same night as transmitter attachment, thus suggesting more extensive involvement in social interactions for these males.

The radiotelemetry data reveal nine instances of adult mice occupying similar locations at the same or different times (Table 5). Eight of the

TABLE 5—Instances of concurrent or sequential occupation of a given location by *Peromyscus leucopus* bearing radio-transmitters. The mice listed in the first column previously occupied the location, unless both mice were observed at the location for the first time (indicated by ?). GHB = groundhog burrow, _n denotes a nursing female; each number identifies an individual

Date	Animals				Particulars
	Num- ber	Sex	Num- ber	Sex	
4 June	1	M?	2	F	Concurrent, rock pile
5 June	3	M	5	M	Concurrent, GHB, within 2 m
5 June	3	F _n	4	M	Sequential, tree nest
6 June	4	F _n	4	M	Concurrent, GHB
7 June	4	F _n	4	M	Concurrent, GHB
8 June	4	F _n	4	M	Sequential, GHB
8 June	4	F _n	4	M	Sequential, GHB
8 June	3	F _n	4	M	Concurrent, leaf litter, within 6 m
9 June	4	F _n	4	M	Sequential, GHB

nine instances involved mice of the opposite sex; the remaining instance involved two males 2 m apart in the same groundhog burrow system. In total, not one instance of double capture or cohabitation between adults involved two females. Three such instances occurred between males, while 10 instances occurred between mice of opposite sex.

Discussion

Several observations on the numbers, movements, and habitat use of *P. leucopus* in this study were unexpected, although the preliminary information on the intensity and specificity of social interactions agreed with expectations. The first unexpected finding was the large spring density of resident *P. leucopus* of 8.4 mice/acre. This compares to normal values of 4 mice/acre (see Terman 1968; Jackson 1961). Although not excessively above average values, the observed density was conspicuous since the habitat structure (i.e., the scarcity of low-level vegetation and hence reduced ground-level cover and food resources) would normally lead to predictions of low density (e.g., see Bendel 1959; Myton 1974; Stickel and Warbach 1960).

Two features of the habitat are believed to have been responsible for the high spring density. First, the dense stand of hickory trees and the conspicuous scattering of nuts on the woodland litter may have supplied a large fall harvest of nuts for winter food needs. The number of shell fragments of hickory nuts, scarred in the characteristic way for *Peromyscus* (Eisenberg 1968; Nicholson 1941), were by far the most common item in the excavated nests. Second, the abundance of groundhog burrow systems, both abandoned and occupied, probably supplied a considerable number of excellent subterranean retreats for winter and spring shelter. Subterranean nests are favored by *P. leucopus* during the winter (Nicholson 1941). It is not known to what degree the closure of burrows by groundhogs during hibernation affects burrow availability during mid-winter. Co-residence by *Marmota monax* and *P. leucopus* in *Marmota* burrow systems, including the accumulation of food items by *P. leucopus*, is the first report of such burrow occupancy. The possibility of reproductive, thermoregulatory, and energetic gains is clear, as

can be deduced from the studies of Millar (1975) and Dudley (1974).

Another unexpected finding was the degree of ground-level activity and the frequent use of subterranean and rock-pile refuges. The habitat, as previously mentioned, was conspicuously open, being influenced primarily by deer grazing. Fallen logs and branches were evident, although not sufficient to obscure vision at ground or eye level for at least 70 m. Previous reports suggested that nesting and foraging in trees should have been more frequent, especially during the spring and summer (Horner 1954; M'Closkey 1975, 1976; M'Closkey and Lajoie 1975; Nicholson 1941). That the transmitters did not cause the ground-level activity is supported by the observations of tree-nest use by *P. leucopus* bearing transmitters (Mineau and Madison 1977). In addition, when the mice were observed in trees, or even when seen running over surface rocks and fallen logs and branches, they did not appear to have problems with balance, agility, or with gripping the substrate or tree bark. Finally, the groundhog, rock-pile, and other ground-level nests showed evidence of long-term occupancy (old nut fragments, layering of old nest material) beginning long before the period of this study.

A third unexpected finding was the tendency of male *P. leucopus* to move into the surrounding fields during much of their nightly (foraging?) activity, but to show the same preference as the females in the type of daytime retreat. The possibility exists that by chance more males than females were selected from areas near fields for radiotracking. The use of grass or early secondary succession fields by *P. leucopus* for foraging has been reported (e.g., Stickel 1968; Whitaker 1966; Pearson 1959), but the relative frequency of use of these fields by mice of different sex has not been examined. The flexibility in diet of *P. leucopus* (Whitaker 1966; Drickamer 1972, 1976) may allow temporary partitioning of the food supply when the spatial intolerance of one sex exceeds that of the other. Hence, nursing or pregnant females could be particularly intolerant of conspecifics and could partially exclude males and non-reproductive females to less favorable areas in the habitat. In the case of isolated woodlots, these less

favorable areas could be the surrounding fields. The possibility of sex differences in diet or habitat use certainly needs additional study before further comments are warranted.

Given the presence of a higher density population of *P. leucopus*, the findings relative to social interactions agree with previous studies. First, the higher frequency of transient mice among the subadult age class is consistent with earlier reports (see Terman 1968), and suggests that not much space exists in the resident population for young reproductives. Second, despite the higher density, the home range sizes are in the range of previous estimates (Terman 1968), and this agreement supports size stability of home range size at different population densities (Metzgar 1971). The much larger 3.1- and 2.3-acre home ranges recorded for transmitted *P. leucopus* in a low-density population (Mineau and Madison 1977) suggests that home range size may vary with extremes in population density, and that the transmitters did not depress home range size in the present study. Third, the preliminary indication of sustained social interaction between mice of the opposite sex, in comparison to mice of the same sex, affirms the observations of Metzgar (1971).

Thus, in conclusion, the potential of radiotelemetry for obtaining more precise information on many aspects of the biology of free-ranging rodents is clear. Even the relatively short term of this study was sufficient to provide new and potentially significant information for *P. leucopus* concerning interspecific coprophagy, interspecific nest cohabitation, and temporary or partial habitat (food?) partitioning between adult males and females.

Acknowledgments

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Prairie Fires and Pronghorn Use of Cactus

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Stelfox, John G. and Harold G. Vriend. 1977. Prairie fires and pronghorn use of cactus. *Canadian Field-Naturalist* 91(3): 282-285.

Abstract. Extensive prairie fires occur frequently on the Suffield Military Reserve as a result of lightning strikes and military operations. Pronghorns (*Antilocapra americana*) were observed feeding on prickly pear cactus (*Opuntia polyacantha*) growing on burnt-over areas. Fires had removed most spines from the cactus plants, providing a source of preferred forage that apparently attracted pronghorns from adjacent unburned ranges.

The Suffield Military Reserve, a 2590-km² (1000-mi²) block of relatively undisturbed native prairie in southeastern Alberta (Figure 1), is owned by the Federal Government and managed

by the Department of National Defence. Except for a 624-km² (240-mi²) area of the Middle Sand Hills and land adjacent to the South Saskatchewan River which has been used for

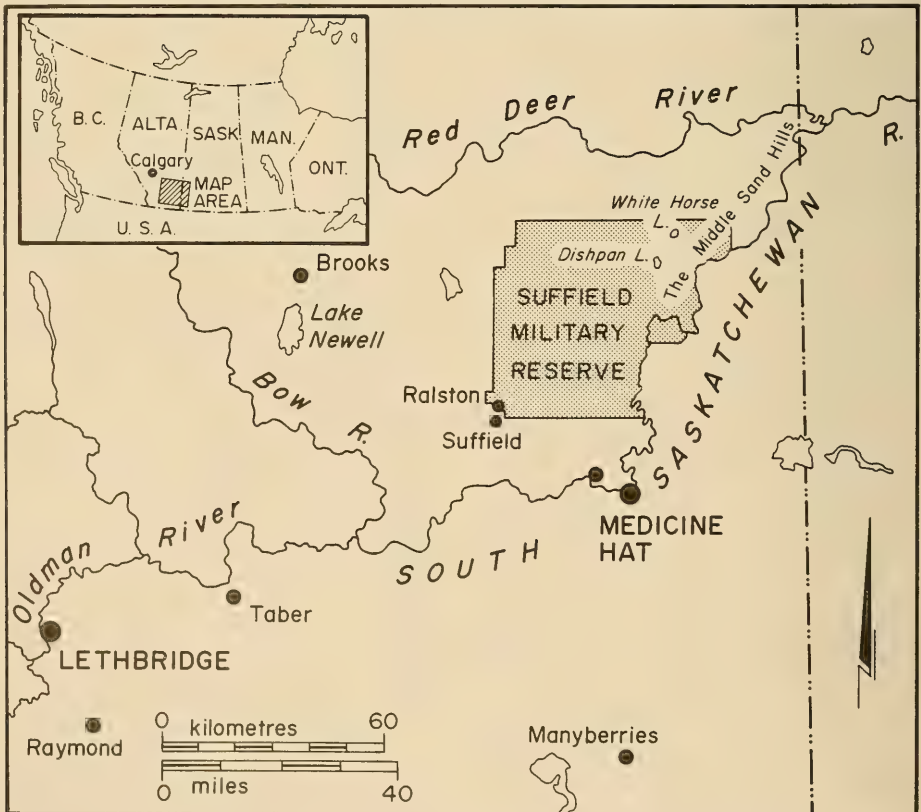


FIGURE 1. Location of the Suffield Military Reserve in southeastern Alberta.



FIGURE 2. A small herd of pronghorns on a recent burn in mixed prairie range. Note the pattern of recent burns over the grassland.

emergency grazing during periods of drought, the remainder has been used for military manoeuvres. In addition, gas exploration activities commenced in the northwest portion of the reserve in 1976. Extensive prairie fires are associated with lightning strikes and military operations. As much as 30% of the range is burned annually as a result of these fires (Cameron, unpublished report). It was on 4 November 1975, while conducting a range survey of the Suffield Block, that the authors recorded incidental observations of the pronghorn antelopes feeding and bedding on these burnt-over areas (Figure 2).

Study Area

The Suffield Military Reserve is located north of the city of Medicine Hat, adjacent to the South Saskatchewan River. It is generally described as mixed-grass prairie with undulating to rolling topography (Figure 2). Hilly areas and sand dunes are present within the Middle Sand

Hills complex, and coulees are present near the river. The variable surficial deposits display dominantly brown Chernozemic soils.

The grassland is predominantly a spear grass – blue grama community (*Stipa comata* – *Bouteloua gracilis*) as reported by Mitchell and Smoliak (1971) and by Jaques (1977). The incidence of silver sage (*Artemisia cana*) is low to moderate throughout most of the area.

The pronghorn (*Antilocapra americana*) is the most abundant wild ungulate on the Reserve, numbering between 750 and 2000 animals depending on its seasonal migratory patterns and weather conditions (Stelfox, unpublished report; Bibaud, unpublished report; Vriend 1977).

Observations

A close examination of the recently burned area on which the pronghorns were foraging revealed no new forage growth since the fire

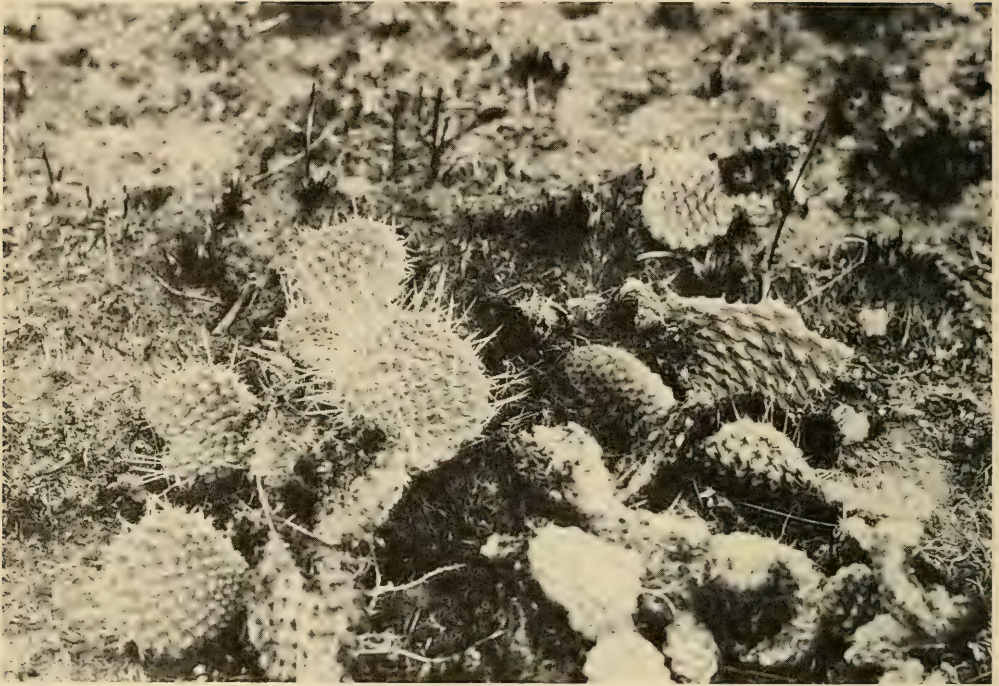


FIGURE 3. A comparison of burnt versus unburnt cactus clones. The unburnt stem on the left was taken from a clone adjacent to the burn and placed next to a burnt and partially eaten clone.

which occurred about one month previous. The only edible vegetation remaining was prickly pear cactus. The recent fire had removed most of the spines from the cactus plants (Figure 3) and the pronghorns had been actively pawing the cactus clones and foraging on the fleshy despined stems. Of about 30 cactus clumps observed within 1 hectare, all had been utilized. Close inspection of one large cactus clone approximately 1 m in diameter, revealed 13 dislodged and 9 intact stems. It was estimated that over 50% of the green stems had been utilized in this burn.

Discussion

Food habitat studies of pronghorn antelopes in Alberta have revealed a low incidence of cactus in the diet. Mitchell and Smoliak (1971) recorded 1% mean volume of prickly pear cactus in the late fall diet of pronghorns in the Manyberries district, 128 km south of Suffield, and 7% and 12% mean volume of ball cactus

(*Mamillaria vivipara*) in spring and fall diets, respectively, of pronghorns in the Newell area, 32 km west of Suffield. Twenty years of range-pronghorn relationships (data unavailable) in a 2.6-km² enclosure near Manyberries stocked with high densities of pronghorns suggested that cactus is more heavily utilized when other food sources are depleted (L. D. Gudmundson, Alberta Fish and Wildlife Division, personal communication).

During the fall period, pronghorns tend to concentrate on areas having an abundance of green vegetation. They are commonly seen feeding on winter wheat (*Triticum sativum*) or alfalfa (*Medicago falcata*) fields in areas where this type of vegetation is available. The succulent nature of the vegetation promotes its use.

Inasmuch as no cropland is available within the Suffield Reserve, the fall use of "spineless" cactus may constitute an important element of the pronghorn's diet in this area.

Management implications are undetermined,

although it appears that restricted fires on areas with a prominence of cactus, especially in drought years, could provide a palatable, nutritious source of forage. A Colorado study (Schoop et al. 1977) determined through chemical analysis and micro-digestion trials that singed prickly pear was a palatable and nutritious food for livestock. Prickly pear contained 40% more soluble carbohydrates than alfalfa; however, it had a low (3.4%) digestible protein content. The digestibility of prickly pear was equal to or superior to that of high quality alfalfa hay.

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Notes

Waterfowl Use of Exotic Wild Rice Habitat in Northern Saskatchewan

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The density of waterfowl populations in the boreal forests of Saskatchewan is known to be much lower than that of the parklands and prairies to the south (Wellein et al. 1964; Anderson and Henny 1972). A few widely scattered pockets of relatively high density (Smith et al. 1964), however, occur in areas such as the Saskatchewan River Delta (Dirschl and Goodman 1967). Surveys conducted during 1975 near La Ronge, Saskatchewan, suggest that planting of wild rice (*Zizania aquatica*) has created locally important high density waterfowl habitat.

Wild rice is not native to Saskatchewan (Dore 1969), its nearest natural range being the east shore of Lake Winnipeg. Experimental seeding occurred in 1935 at Potato Lake, Pine Branch River, Upper Limestone Lake, and Nemeiben Lake near La Ronge (Neilson 1964). Verbal reports indicate that local residents also occasionally scattered seed in lakes and streams in a haphazard manner. In 1964, systematic seeding began (La Ronge Industries, personal communication) and presently La Ronge Industries, assisted by the Department of Northern Saskatchewan, is attempting to expand the acreage of wild rice for commercial production.

During the summer of 1975, the distribution of known stands of wild rice near La Ronge was mapped by canoe and by air photographs. Waterfowl were recorded both in the wild rice stands and in all non-rice areas between the stands. Counts were made during daylight hours. For each month, each site was visited once with the total number of birds seen having been recorded. The amount of non-rice habitat surveyed was not measured but it was certainly many times greater than the area of rice stands.

Wild rice acreage was measured in 11 locations near La Ronge. The total area (Figure 1) was approximately 230 ha. This area excludes the Sikachu Lake rice field which may approach 75 ha and a few other small areas not exceeding 4 ha each. Compared to a total area of more than 1,000,000 ha covered by the map in Figure 1, the extent of wild rice is at present very small.

Even though the total area of wild rice is small, the

TABLE 1—Comparison of the total number of waterfowl (percent in parentheses) observed in wild rice and non-wild rice habitat during June, July, August, and October 1975

	Rice	Non-rice
1-13 June	183 (83)	37 (17)
1-18 July	525 (84)	102 (16)
29 July-15 August	168 (79)	45 (21)
11 October	1725 (99)	10 (1)
Total	2601 (93)	194 (7)

majority of the waterfowl numbers (Table 1), 93% of the 2795 sightings, occurred in wild rice habitat. Greatest waterfowl densities occurred during October, suggesting use of wild rice as a staging area. Fortunately for those endeavoring to crop wild rice, this influx of birds occurred after the harvest. But evidence of damage to wild rice crops is noticeable (Kaz Parada, personal communication). Lesser Scaup (*Aythya affinis*), Goldeneye (*Bucephala clangula*), and Mallard (*Anas platyrhynchos*), respectively, ranked as the three most common species. Seventy-four of the 525 waterfowl in wild rice habitat during July were young of these three species indicating some use of wild rice habitat for breeding. The importance of these observations lies not in the magnitude and accuracy of the numbers but rather in the fact that waterfowl numbers were greatest in a very small exotic habitat type, namely wild rice.

There are two plausible explanations for this phenomenon. Either waterfowl are attracted directly to the wild rice or wild rice is adapted to the same habitat features that waterfowl select. If the first explanation is true, then abundance of waterfowl has likely increased with man's importation of wild rice. This trend may well continue if wild rice acreage continues to expand. If the second explanation is valid, one might expect that waterfowl, especially Lesser Scaup and Mallard, could be a useful indicator of potential sites for future wild rice seeding.

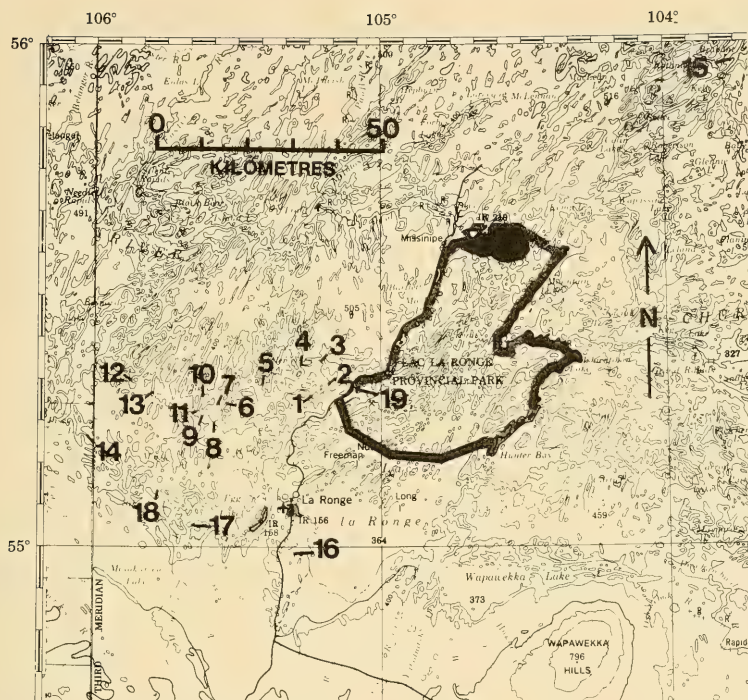


FIGURE 1. Location of wild rice stands near La Ronge, Saskatchewan. The names and areas for each designated stand are as follows: 1, Mud Bay 5.8 ha; 2, East of Whitmore Island 3.4 ha; 3, North end of Nemeiben Lake 6.4 ha; 4, Three Portage Bay 16.7 ha; 5, Jackfish Bay 13.2 ha; 6, Miller channel 2.2 ha; 9, Pine Branch River 69.7 ha; 10 and 11, Howard Lake 11.0 ha; 12, Morning Lake 76.0 ha; 13, Trivet Lake 16.1 ha; and 16, Potato Lake 10.3 ha. Traces resulting from new seed were found at stands 7 and 8 (Head Lake) and 14 (Pisew Lake). Areas 17, 18, and 19 respectively, designate Egg Lake, the Sikachu River, and Waden Bay from which estimates of areas were not available.

Whichever explanation is the case, this man-made alteration to what is often considered a pristine wilderness deserves future consideration.

Acknowledgments

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The Wolffish, cf. *Anarhichas denticulatus*, New to the Amundsen Gulf Area, Northwest Territories, and a Probable Prey of the Ringed Seal

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Smith, Thomas G. 1977. The Wolffish, cf. *Anarhichas denticulatus*, new to the Amundsen Gulf area, Northwest Territories, and a probable prey of the Ringed Seal. Canadian Field-Naturalist 91(3): 288.

On 16 May 1974 while hunting Ringed Seals (*Phoca hispida*), two Inuit from Holman, Northwest Territories, found the carcass of a Wolffish (*Anarhichas* sp.). The 13.6-kg, 127.0-cm-long carcass was found floating in the breathing hole beside a seal which they had shot on the ice. The hunting area was near Iluvilik Island (70°37' N, 116°32' W) in Prince Albert Sound on western Victoria Island. The area in the gill region and ventrally had been chewed away and the viscera were completely missing. The body showed many scratch marks similar to those inflicted by the claws of the foreflippers of the seal on Arctic Char fed to them in captivity. The fact that the Wolffish carcass was found in the breathing hole is strong evidence that the seal had been feeding on it.

Few people in the Holman region had seen this species of fish before. A few older hunters knew the local Inuit name which is *akoak* or *akoaksaluk* (old woman fish). Two hunters, some years before, had found an even larger specimen frozen into the surface of the sea-ice near the same area, but did not know how the carcass had arrived there.

Unfortunately, we were unable to collect the specimen or to make a positive species identification in the field. From photographs of the carcass, its gray color and large size, it has tentatively been identified as *Anarhichas denticulatus* Krøyer (D. McAllister, National Museum of Natural Sciences, personal communication). The closest known locality for *A. denticulatus* is 620 km to the north in Mould Bay, Prince Patrick Island (Walters 1953). Another closely related species, *A. orientalis*, is known from the Bering Sea and north Pacific Ocean (Barsukov 1959) and has been reported to the southeast of the present area in Bathurst Inlet (Legendre et al. 1975).

The Ringed Seal which apparently successfully caught this specimen was shorter in total length (121 cm) than its prey. The Ringed Seal is not generally known as a predator of large fish and most data on its feeding habits come from the examination of stomach contents. From these it has been described as primarily a fish eater during the ice-covered months. Its main prey species is the Arctic Cod,

Boreogadus saida, which rarely exceeds 160 mm in length and 35 gm in weight, in this area. It also feeds on the Saffron Cod, *Eleginus* sp., and on the Polar Cod, *Arctogadus* sp., which rarely exceed 400 mm and 500 mm in total length, respectively. Evidence of utilization of larger fish might easily be missed in analyses of stomach contents, especially when the head is not eaten. Identification of fish remains depends primarily on otoliths or a sufficiently large intact piece of the body.

We know from observations on captured Ringed Seals that they can and will actively pursue and kill large fish in the confines of their holding pens. Observations of seals fed live Arctic Char, *Salvelinus alpinus*, showed a consistent hunting behavior. The seal would actively pursue the fish, repeatedly biting them behind the head in the gill area. Large char took a fairly long time to subdue. A 7.71-kg char died after 22 min of pursuit and attack. We conclude that large fast-moving fish, such as Arctic Char, would not likely be a normal constituent of the Ringed Seal diet in the wild. The Wolffish, primarily a bottom feeder, however, is a rather sluggish swimmer which might easily be caught and eventually killed by a seal. Recent evidence indicating that the Ringed Seal is capable of deep and extended dives supports this idea (Geraci and Smith 1975).

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Locations of Winter Dens Utilized by Striped Skunks in Delta Marsh, Manitoba

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Mutch, Graham R. P. 1977. Locations of winter dens utilized by Striped Skunks in Delta Marsh, Manitoba. *Canadian Field-Naturalist* 91(3): 289-291.

Abstract. Locations of winter dens utilized by Striped Skunks in Delta Marsh, Manitoba were determined by tracking free-ranging skunks in snow. Skunks selected wet low-lying areas in preference to a drier sandy ridge and a dike (road embankment) for den sites. Higher soil temperatures, less extreme snow conditions, and greater substrate stability are possible explanations for den-site preference contrasting with the results of studies in other areas.

Burrowing mammals that become inactive during winter must find or prepare suitable dens for occupancy during late fall, winter, and early spring. An optimal den site theoretically would be in stable well-drained soil in an area not subject to flooding in spring and would be sufficiently deep that the nest chamber would not freeze. This paper describes the locations of 19 dens used by Striped Skunks (*Mephitis mephitis*) during winter in Delta Marsh, Manitoba (50°11' N, 98°23' W). This location is 5-6° of latitude south of the northernmost part of the skunk's range at this longitude (Hall and Kelson 1959). Skunks undergo a near-complete cessation of surface activity in this area during winter (Mutch 1976). Data on soil temperatures and snow conditions in the various areas utilized are also presented.

Study Area and Methods

The study was conducted at the University of Manitoba Field Station, Delta Marsh on a 2.5-km strip of land adjacent to and paralleling Lake Manitoba. Based on differences in topography and flora, the area may be subdivided into three sub-areas. The first, a 50- to 200-m-wide sandy ridge immediately adjacent to the beach supports stands of *Populus* spp., *Salix* spp., *Sambucus pubens*, *Acer negundo*, and other tree and shrub species with a dense understory of herbs. In the second sub-area, a marsh-meadow community, *Typha latifolia* and *Scirpus* spp. fringe open water in natural channels and man-made borrow pits. Seasonally flooded sites support *Scholochloa festuacea* and *Phragmites communis* while drier meadows are characterized by *Agropyron repens*, *Hordeum jubatum*, *Sonchus arvensis*, *Cirsium arvense*, and *Melilotus alba*. The third sub-area is a 2- to 3-m-high dike embankment, the top of which is a gravelled road. Its sides support a dense mixed stand of *Bromus* sp., *Medicago sativa*, and *Melilotus alba*, which may be mowed in summer. Walker (1959) has

described the vegetation of Delta Marsh in detail.

Weekly records of soil temperatures were obtained between late October and mid-May using telethermometer probes buried at a depth of 90 cm at one site in each sub-area described. The October marsh water table was at approximately 90 cm but in the ridge and dike embankment it was deeper. Snow depths were recorded weekly at each of 12 permanent snow stations in each sub-area, as well as an indicator of snow hardness, the pressure (in grams per square centimetre) required to compress the surface snow 2 or 3 cm or to break the surface crust.

Occupied skunk dens were found in fall and spring by following skunk tracks in snow and seeking evidence of fresh digging together with skunk tracks at den mouths.

Results

Soil temperatures at a depth of 90 cm in each sub-area are depicted in Figure 1. Prior to heavy snowfall in autumn, rapid declines in soil temperature occurred at all three locations. After the arrival of heavy snow, marsh soil cooled very gradually. Soil temperatures at a depth of 90 cm remained above 1°C for the rest of the winter. In May, warming of marsh soil was also very gradual. Changes in temperature of soil at the same depth in the wooded ridge followed a similar pattern, although soil here was consistently about 1°C cooler than in the marsh (Figure 1). The coldest soil was in the dike embankment where temperatures as low as -3°C were recorded in mid- to late February.

Snow depths varied considerably in different sub-areas (Figure 2). The 130-cm cumulative snowfall recorded at the University Field Station was subject to relatively little drifting in the marsh where vegetation tended to hold it in place. Because little compaction occurred here the snow that accumulated remained soft and loose, generally requiring pressure of less than 6 g/cm² to compact it 2 or 3 cm. The dike was

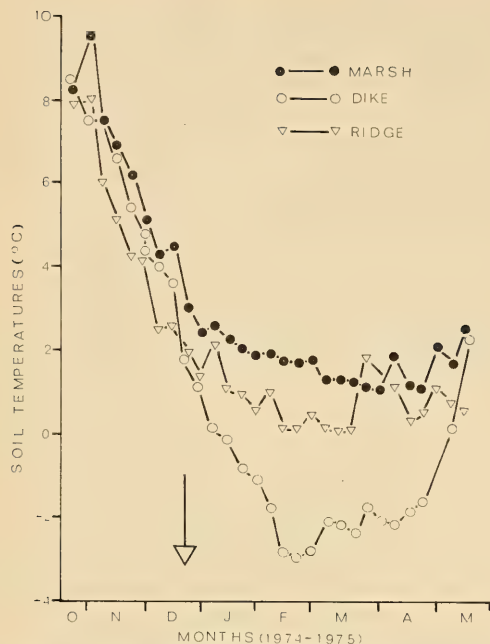


FIGURE 1. Weekly soil temperature readings at 90-cm depth in the marsh, dike embankment, and wooded ridge sub-areas at Delta Marsh, Manitoba for the period October 1974 to May 1975. The arrow indicates the first heavy snowfall of the season.

windswept and the road surface snow-free. Mowed embankment slopes trapped little snow, which melted in early March, especially on the east-facing slope. Snow rarely became hard here. On the wooded ridge snow blown from the adjacent lake accumulated into deep hard drifts. These drifts were deepest between the center of the ridge and the lake. Drifts were frequently very hard, requiring up to 100 g/cm² to compact the snow 2 or 3 cm. In areas where the ridge was more than 100 m wide, drifts were often absent on the downwind (marsh) side.

Few skunk tracks were found in November and December and none were found in January and February. Tracks became common in March and April. Skunk tracks on the ridge were always uncommon except immediately adjacent to the marsh. Greatest concentrations of tracks were found in the marsh.

I found 19 dens that were repeatedly utilized by skunks and none of these was located in the ridge. Three were on the marsh-ridge boundary where the flora was similar to that of the marsh and soil was similar in wetness and structure to marsh soil. These

sites were beyond the range of deep hard drifts. No active skunk den was found on the dike embankment. Three were found on other, slightly raised road embankments and one beneath an old culvert. Snow in these areas was less than 0.75 m deep, and soft. Vegetation consisted of forbs and grasses. In no case were these dens in snow conditions similar to those prevailing in the wooded ridge. The remaining 12 dens were located in the marsh, eight in stands of *Phragmites communis*. It was not possible to determine what species had originally excavated the dens although the marsh dens showed signs of having been dug by skunks.

Discussion

This survey presents evidence that Striped Skunks in Delta Marsh occupy winter dens located in flat low-lying areas, often in *Phragmites* stands. Although surface litter may be dry, these sites have heavy,



FIGURE 2. Weekly mean snow depths in the marsh, on the dike embankment, and in the wooded ridge (12 stations in each sub-area) at Delta Marsh, Manitoba, for the period October 1974 to May 1975. Cumulative snowfall was determined by summing records for all snowfall measured at the meteorological station at the main University Field Station compound in Delta Marsh.

poorly drained soils and a high water table. Complete inundation invariably occurs in March or early April upon melting of the snow. These features are apparently disadvantageous to winter denning in the marsh sub-area. Burrows dug by hibernating rodents are present in the ridge, and skunks could possibly modify these to their own purposes if denning in the ridge were otherwise acceptable. Other studies indicate that burrowing mammals consistently avoid wet areas for winter den sites. Skunks have been found to select hilly or rolling country for their winter dens, which are often on well-drained slopes (Selko 1938; Scott and Selko 1939; Allen and Shapton 1942; Verts 1967). Bailey (1971) found that skunks in a Lake Erie marsh denned exclusively in artificial dikes. Houseknecht (1969) reported that skunks denned almost entirely in upland sites in winter; in summer a significant proportion of nest sites, many of them aboveground, were reported in lowland areas by Houseknecht (1969) and Storm (1972).

Local conditions peculiar to the study area may necessitate winter denning in sites avoided in other environments. True uplands are lacking in the strip of marsh and wooded ridge paralleling Lake Manitoba. The wooded ridge, despite dryer soils, a lower water table, and very localized spring flooding has limitations. The soil is essentially pure sand and may be too unstable to support construction of large dens, although hibernating rodents do den there. Hard snow, 2 m or more in depth, blankets the ridge until May and could impede or even prevent entrance to, or emergence from, dens in spring. Sunquist (1974) believed that particularly deep and heavy snow was at least partially responsible for delaying spring emergence of skunks in Minnesota. Easy entrance to the den is essential during the rut in March and April (Verts 1967). The dike embankment is well-drained and its soil is firm. It is blown clear of snow, and soil temperatures at 90 cm depth fell to below freezing for extensive periods. Lower ambient temperatures at more northern latitudes may make it necessary that skunks den in the warmest areas possible. Soft snow provides insulation to soil in the marsh and is not deep enough to trap skunks in their dens. The air layer between the soil and the previous summer's *Phragmites* growth, which has been flattened by the weight of the snow, is excellent insulation. Ground water in wet areas is a reservoir of heat ensuring higher soil temperatures (the recorded minimum marsh sub-area temperature at 90 cm depth was 1.1°C, compared to 0.1 and -3.0°C in the ridge and dike respectively).

These factors are believed to be important in winter den-site selection by Striped Skunks in Delta Marsh. This marsh is excellent habitat for skunks, particularly in relation to seasonal food abundance, including voles, duck eggs, and frogs. The absence of

sites preferred for denning in other regions has not prevented skunks in Delta Marsh from reaching high populations, estimated at 20-32/km² by Lynch (1972). It is therefore evident that the Striped Skunk has adapted to the local conditions and that marsh dens do in fact fulfill their den requirements.

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Age and Fecundity of the Tadpole Madtom, *Noturus gyrinus*, on Long Point, Lake Erie

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Mahon, Robin. 1977. Age and fecundity of the Tadpole Madtom, *Noturus gyrinus*, on Long Point, Lake Erie. Canadian Field-Naturalist 91(3): 292-294.

Abstract. Specimens collected from lagoons on Long Point, Lake Erie, in May and August, belonged to ages 1+, 2+, and 3+, as determined from vertebrae. The relationship of $\log \text{Fecundity} = 1.918 \log \text{SL} - 0.148 \log \text{EW} - 1.750$, where SL is standard length and EW is mean weight of one egg, was found for 33 ripe females collected in May.

There is no published study of the biology of the Tadpole Madtom, *Noturus gyrinus*, in Canada (Scott and Crossman 1973) and little elsewhere (Carlander 1969). This species has been aged using vertebrae (Hooper 1949), and an average number of 50 eggs per female, with a maximum of 93 has been reported (Everman and Clark 1920). Scott and Crossman (1973) noted a specimen with 117 eggs.

Methods

Specimens were collected from lagoons on the eastern end of Long Point, Lake Erie (42°32' N, 80°07' W), using an electric fish shocker or after treatment with rotenone (Mahon and Balon 1977). Sample 1, taken in the last week of May 1975, was from the inshore of a large lagoon (about 25 ha) in depths of less than 1 m. Sample 2, taken in the first week of August, was from several small, isolated lagoons (up to 600 m²) peripheral to the same large lagoon.

After preservation in 10% formalin, fish were sexed, weighed, and their standard and total lengths measured to the nearest millimetre. Ovaries containing ripe eggs were removed and the number and combined weight of these eggs recorded. Division of the combined weight of ripe eggs by their number gave the mean weight of one ripe egg (EW) for each female.

Two fish from each 1-mm-length interval in each sample were aged using vertebrae. A vertical incision

was made immediately posterior to the dorsal fin, and four vertebrae anterior to the incision removed. After being allowed to dry, the vertebrae were separated using a thin blade, and the surfaces of the centra were viewed under direct light using a binocular microscope. Dark and light growth bands were visible on both surfaces of the centra. The annulus was considered as a transition point from a dark band to a light band. The age assigned each fish was the same as the number of annuli observed, with a plus sign to indicate growth subsequent to annulus formation (Balon 1972).

Results

Length frequency histograms for samples 1 (May) and 2 (August) are shown in Figure 1. Table 1 shows mean standard length, range in length, and the number of males and females at each age for each sample. Ages are also superposed on Figure 1 so that age groups as obtained from the vertebrae may be compared to the peaks of the histograms.

The relationship between weight (W) and standard length (SL) for all fish was best expressed by a linear regression of logarithmic transformed data. Two such regressions were fitted, one for the ripe females: $\log W = 3.18 \log \text{SL} - 4.86$ ($r = 0.97$), and the second for all other fish: $\log W = 2.91 \log \text{SL} - 4.533$ ($r = 0.97$). The regression coefficients for these regressions are significantly different ($P < 0.05$).

TABLE 1—Mean standard length (mm), range of length, and number of males and females at each age in May and August, for *Noturus gyrinus*

	Sample 1 (May)			Sample 2 (Aug.)		
	1+	2+	3+	1+	2+	3+
Mean length	36	55	63	52	75	83
Range	25-51	45-65	60-69	40-66	58-85	80-87
Number of males	128	32	9	30	58	6
Number of females	129	25	2	32	22	1

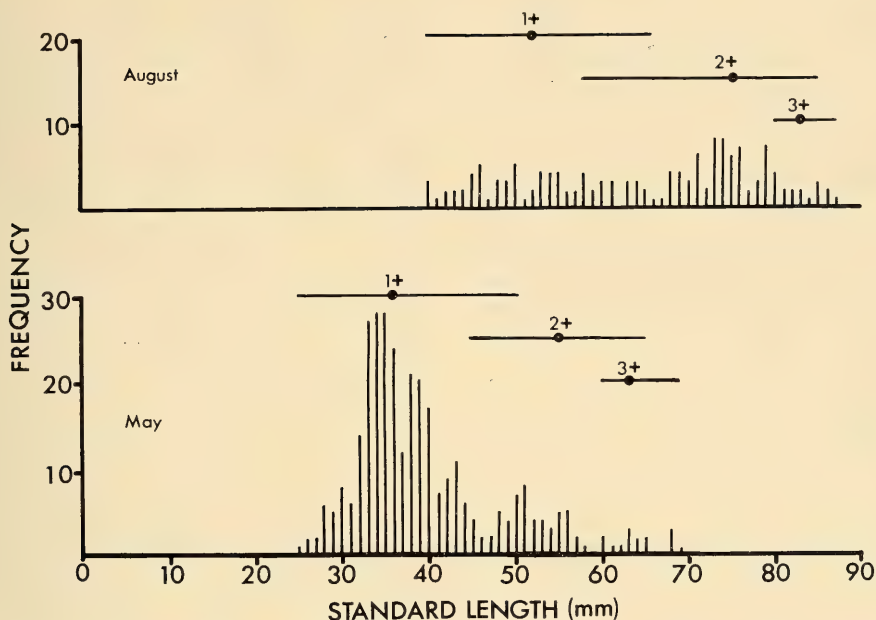


FIGURE 1. Length-frequency histograms for the Tadpole Madtom, *Noturus gyrinus*, in May (325 individuals) and August (149). Horizontal lines give the range in length at each age with the mean length indicated by a closed circle.

Standard length and total length (TL) are related in the following way: $\log TL = 0.958 + 0.152 \log SL$, as determined by a linear regression of $\log TL$ on $\log SL$.

Ripe females were taken in both May and August. Those from August showed signs of having already spawned some of their eggs and were not used for fecundity counts. In May, 10% of age 1+ females, 72% of age 2+ females, and both age 3+ females were mature. The number of ripe eggs per female varied from 43 to 160. Only 65.1% of this variation can be accounted for by variation in standard length when a linear regression of $\log F$ on $\log SL$ is fitted. A further 6.2% can be accounted for by considering variation in egg weight, as was done by Scott (1962). The regression equation for the trivariate relationship of $\log F$ on $\log SL$ and $\log EW$ is $\log F = 1.918 \log SL - 0.148 \log EW - 1.750$ ($r = 0.844$). There is significant positive correlation between $\log SL$ and $\log EW$ ($r = 0.703$).

Discussion

The absence of 0+ fish in the August sample is probably owing to their small size at this time. Case (1970) reports that 0+ *Noturus gyrinus* emerged in early August in a Manitoba river. For sample 1 fish, mean lengths at ages 1+ and 2+ correspond to peaks in the length-frequency histogram (Figure 1), suggesting

that this method of aging is valid. There is no distinct peak of 3+ fish, however, and the conclusion that individuals do survive to 3+ years rests on the vertebral growth ring counts alone.

The only comparable growth study is that of Hooper (1949) for *Noturus gyrinus* from Demming Lake, Minnesota, where growth was faster than in Long Point lagoons. In Demming Lake, where this species was dominant in standing crop and numbers, mean standard lengths of 26 mm (range 15–35 mm), 62 mm (range 43–85 mm), and 89 mm (range 78–104 mm) had been achieved by age 0+, 1+, and 2+ fish respectively on August 15. Though growth was faster in Demming Lake than on Long Point, mortality between ages 1+ and 2+ appears to have been much higher (97.4% and 77.8% respectively). Had mortality of age 2+ fish in Demming Lake been similarly high there would have been only seven or eight 3+ fish in the whole lake from which sub-samples were taken for aging. Considering the percentage mortality between ages 1+ and 2+ in Long Point lagoons the finding of individuals aged 3+ is not unexpected.

Noturus gyrinus nests and guards a few large yolky eggs which are usually hidden (Hankinson 1908; Bailey 1938). For this reproductive style, longevity and the accompanying increase in size and experience

would seem advantageous, yet most females mature at age 2+ and therefore probably reproduce only once. Case (1970) found that toxin injected directly from the pectoral spines of live *Noturus gyrinus* into the lateral musculature of a sauger, *Stizostedion canadense*, a northern pike, *Esox lucius*, and a rainbow trout (fry), *Salmo gairdneri*, produced varying degrees of immobilization almost immediately. *Esox lucius* (30 cm) was most severely affected, turning belly up after 15 min. The manufacture of a toxin could serve as a substitute for increased size (Hairston et al. 1970) enabling *Noturus gyrinus* to defend its nest effectively against large predators either actively or as the result of learned avoidance on the part of the predator, and at the same time retain the small size needed for exploitation of its accustomed habitat.

Acknowledgments

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The Little Gull (*Larus minutus*) in Arctic North America

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Johnson, Stephen R. and William J. Adams. 1977. The Little Gull (*Larus minutus*) in Arctic North America. Canadian Field-Naturalist 91(3): 294-296.

On 16 June 1975, at approximately 1830 hours Yukon Standard Time (YST), we observed a Little Gull (*Larus minutus*) in association with approximately 30 Arctic Terns (*Sterna paradisaea*) manoeuvring over a flooded tundra marsh approximately 1 km southwest of the Komakuk Beach DEW Station, Yukon Territory (69°36' N, 140°11' W). WJA first watched the gull from a distance of 20-30 m for approximately 10-15 min with the aid of 8 × 35 binoculars and made his tentative identification from a field guide (Robbins et al. 1966) that he carried with him. Approximately 10 min later, we

both observed a Little Gull at approximately the same location; we again compared the bird under scrutiny with the painting and description in the field guide. Neither of us had seen a Little Gull previously.

Although the bird was silent, we recorded the details of its behavior and appearance. The gull was hooded and was obviously smaller than the terns with which it was associated. The undersides of its wings were slatey-black and the uppersides of the wings were dark gray; we noted no other markings on the wings except their white posterior and distal margins. The gull had red legs and a red bill. We saw Sabine's

Gulls (*Xema sabini*) in the Komakuk area previous to this sighting of the Little Gull, and we were careful to look for characteristics that distinguished this new gull from a Sabine's Gull.

We continued surveying the area near this marsh during the evening of 16 June and at approximately 2000 hours YST we found two Little Gulls there, also associated with Arctic Terns. In the afternoon of 17 June, we saw two Little Gulls flying northwest over a portion of the still frozen Beaufort Sea approximately 300 m from the beach at Komakuk. Both of these birds were heard giving their "kek-kek-kek" call; they were not associated with any other species.

The first North American specimen of a Little Gull was collected during the first Franklin Expedition sometime between 1819 and 1822, apparently in the area between the Coppermine River, Northwest Territories, Canada and York Factory, Manitoba, Canada (Baillie 1963, pp. 95-97). Baillie (1963) recorded the apparent invasion of eastern North America by the Little Gull; he documented several Little Gull specimens taken in eastern North America since 1887 and the discovery reported by Scott (1963) of the species' first nest and eggs in the New World on 1 June 1962 near Oshawa, Ontario. Tozer and Richards (1974, pp. 342-346) described subsequent nesting activities in the Oshawa area and near Rondeau Park and Cranberry Marsh, Ontario. Erdman and Steffen (*in Tessen* 1975) reported Little Gulls nesting in north-central Wisconsin during the summer of 1975, the first nesting record of this species in the United States. The Little Gull is now regularly sighted and is fairly common in these portions of the Great Lakes region.

The first recorded appearance of the Little Gull along the west coast of North America was on 16 November 1968 near Riverside, California (McCaskie 1969) and during recent years Little Gulls have appeared regularly along the southwestern coast of British Columbia (Tatum 1973; Campbell et al. 1974; M. G. Shepard, personal communication).

McNicholl (1974) recently reported a possible sighting of a Little Gull in southern Manitoba, and Switzer (1974) reported a recent observation of one in Regina, Saskatchewan. Green (1974) reported Little Gulls associated with Arctic Terns in Duluth, Minnesota.

In the north, the only comparatively recent New World specimen of a Little Gull was a male collected by Nero (1963) on 26 June 1963, 11 km (7 mi) south of Beaver Point (59°2' N, 109° W) on the south side of Lake Athabasca, Saskatchewan. More recently, Pittaway and Nero (1971) reported a sighting of this species at Churchill, Manitoba.

Baillie (1969) mentioned that in recent times the

Little Gull has been a rare but regular visitor in eastern North America and that this species is frequently seen during winter, fall, and spring in company with Bonaparte's Gulls (*Larus philadelphia*). Baillie (1951) hypothesized that Little Gulls "colonized" North America from Siberia. According to this hypothesis Little Gulls may have migrated southeast from their Siberian nesting area to the Bering Sea where they may have encountered breeding Bonaparte's Gulls (Baillie 1951). After this encounter, according to Baillie, both species then presumably continued southeast to the eastern wintering grounds of Bonaparte's Gull along the North American east coast.

Our coastal Yukon observations, viewed in light of the specimen from Lake Athabasca and the initial Franklin Expedition specimen, lend superficial credence to Baillie's hypothesis. Neither Dement'ev et al. (1951) nor Vaurie (1965), however, describe nesting areas of the Little Gull in far eastern Siberia or in the vicinity of the Bering Sea, although Dement'ev et al. (1951) do mention the possibility of Little Gulls wintering in the Sea of Okhotsk. Further, Bonaparte's Gulls nest in only a few isolated places near the Bering Sea coast in western Alaska and there are no records of Little Gull specimens or sightings in Alaska (Gabrielson and Lincoln 1951; D. D. Gibson, personal communication). The probability seems low that an encounter between these two species would occur in the Bering Sea area.

In the Old World, Little Gulls commonly winter in large numbers along the coast of Great Britain and along the Iberian and Mediterranean coasts (Vaurie 1965; Brunn 1970). Thus it seems more probable that Little Gulls originally "colonized" eastern North America from their wintering grounds in Europe. Subsequently, through their association with Bonaparte's Gulls, as suggested by Baillie (1951) and as indicated by more recent sightings (Pittaway and Nero 1971; McNicholl 1974; and others), Little Gulls may have wandered to the Canadian Arctic from their wintering grounds in eastern North America.

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Summer Food Habits of Golden Eagles in Southwestern Alberta

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Boag, D. A. 1977. Summer food habits of Golden Eagles in southwestern Alberta. Canadian Field-Naturalist 91(3): 296–298.

Olendorff (1976), in reviewing the literature on the food habits of Golden Eagles (*Aquila chrysaetos*) in North America, requested that "others . . . report their findings to give us a still better assessment of the economic impact of Golden Eagles." This note records the food habits of a pair of Golden Eagles during the summers of 1955 and 1958 at a nest site in southwestern Alberta. At that time the eagles occupied a nest on a cliff face of Missing Link Mountain (114°38' W, 50°39' N), 30 km west of Turner Valley, Alberta.

Periodic visits to the nest site spanned a period of 106 days in 1955 (5 May to 18 August when the single eaglet fledged) but only 58 days in 1958 (2 June to 29 July during the nestling period of the single eaglet). I was able to record only the unconsumed remains of

prey present in the nest on each visit. Nearly all bird and mammal remains had at least one limb intact, enabling me to mark them by removing the toes; thus, I could leave them at the nest site as potential food, yet avoid recording them more than once. In each instance I was able to identify the species of prey and, in most cases, to determine their sex and age.

The nest site was visited on 79 days in 1955 (18 in May and 3 in June during incubation, and 21 days in June, 25 in July, and 12 in August during the nestling period) and on 11 days in 1958 (5 in June and 6 in July during the nestling period).

The prey items are recorded in Table 1. In both years, mammals made up more than 80% of the diet; the primary prey species was the Columbian ground squirrel (*Spermophilus columbianus*). This

TABLE 1—Prey items recorded at a Golden Eagle nest site located in southwestern Alberta. Data were recorded during the nestling periods of 1955 and 1958

Prey species	Percent of total, 1955 ¹		Percent of total, 1958	
	Individuals	Biomass ²	Individuals	Biomass ²
Birds				
Galliformes				
<i>Dendragapus obscurus</i>	8	15	8	12
<i>Bonasa umbellus</i>	1	< 1	3	2
Piciformes				
<i>Colaptes auratus</i>	0	0	3	< 1
Passeriformes				
<i>Pica pica</i>	0	0	3	< 1
Total	9	15	17	15
Mammals				
Carnivora				
<i>Mustela frenata</i>	1	< 1	0	0
Rodentia				
<i>Spermophilus columbianus</i>	80	77	79	82
<i>S. lateralis</i>	4	2	5	3
<i>Thomomys talpoides</i>	1	< 1	0	0
<i>Neotoma cineria</i>	1	< 1	0	0
Lagomorpha				
<i>Lepus americanus</i>	1	2	0	0
Artiodactyla				
<i>Odocoileus hemionus</i>	2	2	0	0
Total	90	84	84	85

¹Two additional *Spermophilus columbianus* and one *Dendragapus obscurus* were recorded in the nest during the incubation period.

²Estimated from average weights of the sex and age class killed in particular months (Boag 1958; Adams 1962; Boag, unpublished data).

species as well as golden-mantled ground squirrels (*Spermophilus lateralis*) were not recorded among the prey of the Golden Eagle by Olendorff (1976), although Salt and Wilk (1958) recorded Columbian ground squirrels in the diet of Golden Eagles, based on data from this study. Birds made up less than 20% of the diet, with Blue Grouse (*Dendragapus obscurus*) being the most important avian prey species, accounting for 8% of the individuals but 15% of the biomass.

During the incubation period of 1955, food items were brought to the nest only before 9 May. It was not until 5 June, the day the eaglet hatched, and thereafter, that additional items were recorded. This suggests that the incubating bird did most of its feeding away from the nest site.

In both years, the amount of food brought to the nest appeared to exceed that consumed by the single eaglet. Many food items remained in the nest long enough to become partially buried in new nest material that was added throughout the nesting period by the adults. Whether these remains were eventually consumed by the eaglet or the adults or whether they were discarded is not known.

On three occasions during the nesting period, several Columbian ground squirrels were shot, marked, and left in the middle of a little-used trail

about 600 m from the nest site. On each occasion one or more of these squirrels was subsequently found in the nest and then consumed. This confirms that Golden Eagles take carrion to the nest for consumption, a characteristic also noted by Olendorff (1976). Furthermore, I suspect that the remains of the two mule deer (*Odocoileus hemionus*) fawns, found in the nest in 1955, represented carrion. All that remained of these deer were the scalps and attached ears. Neither showed any signs of subcutaneous hemorrhaging resulting from either pecking or claw punctures, lesions that are so apparent on the inner surface of skins of small mammals killed by these birds. Apparently only the heads of these fawns were brought to the nest site.

The species composition of prey taken by these eagles probably reflected the relative availability of the prey species. Columbian ground squirrels, living in colonies in the grassy meadows located along the base of the cliff face on which the eagles were nesting, were readily available (34.6/ha) (Adams 1962). Similarly, Blue Grouse were present at high densities (33.8 to 54.8 grouse/100 ha) throughout the area hunted by the eagles at that time (Boag 1958).

Among the ground squirrels, the eagles appeared to be selecting certain age and sex classes (Table 2).

TABLE 2—The age and sex composition of Columbian ground squirrel remains found at the nest site of a pair of Golden Eagles in 1955

Month	Adult			Juvenile	
	Male	Female	Unknown	Male	Female
May	2	0	0	—	—
June ¹	10	11	1	0	1
July	22	10	2	0	0
August	6	0	1	1	2
Total	40	21	4	1	3

¹Sex and age of squirrel remains found in 1958 were recorded only on 2 June when six adults were examined; four were males and two were females.

Juvenile Columbian ground squirrels did not emerge above ground until July, after which their relative availability continued to increase as adults returned to hibernation in late July and August (Adams 1962). There was no evidence, however, that juveniles formed an appreciable component of the diet, even in August. Golden Eagles may select adults over juveniles because of differences in energy return for effort expended or in vulnerability. Another possibility is that juvenile squirrels, being smaller, were more likely to have been completely consumed and thus missed being recorded.

Among adult ground squirrels taken by the eagles, I recorded significantly more ($\chi^2 = 5.92$; $P < 0.05$) males than females overall. This apparent selection became more pronounced as the season progressed and suggests that male squirrels are more vulnerable than females.

Olendorff (1976) recorded food items of Golden Eagles in terms of individuals but not biomass. Among the 7094 vertebrate remains reported from Golden Eagle nest sites throughout temperate North America (Olendorff 1976), 5953 (84%) were mammals; birds made up 15% of the remains and only 1% were other vertebrates. In a four-year study of this species in south-central Montana, McGahan (1968) found that mammals made up 87% of the diet and birds 12.4%. These proportional representations in the diet are amazingly similar to that recorded in this study and suggest a constancy in either prey selection by, or prey availability to, Golden Eagles throughout the temperate part of their North American range. Such constancy appears to contrast with the situation in the Arctic where ptarmigan (*Lagopus* spp.) apparently make up a much larger proportion of the diet in some years (Hatler 1974). A similar phenomenon has been recorded in at least one other arctic-nesting member of the Buteoninae, *Buteo lagopus*, the diet of which varies markedly with changing availability of small mammals on the tundra (Pasanen and Sulkava 1971); mammals make up 80–90% of the diet in most years but, in one year of five, birds made up 70% (Pasanen 1973).

In summary, the relative proportions of birds and mammals in the diet of these Golden Eagles were remarkably similar to those reported in the literature from other parts of temperate North America; however, a new primary prey species, the Columbian ground squirrel, was recorded. The different sex and age classes of these squirrels were apparently subjected to differential predation pressure by the eagles; adult squirrels evidently were selected over juveniles and males over females.

I am grateful to the late R. B. Miller who encouraged me to undertake this study while I was his field assistant, and W. D. Wishart who helped collect some of these data. Financial assistance, received from The Edmonton Bird Club through a scholarship and from the Alberta Department of Lands and Forests, is gratefully acknowledged. R. W. Fyfe offered constructive comments on an early draft of the manuscript.

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The Occurrence of a Narwhal (*Monodon monoceros*) in Prince Albert Sound, Western Victoria Island, Northwest Territories

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Smith, Thomas G. 1977. The occurrence of a narwhal (*Monodon monoceros*) in Prince Albert Sound, western Victoria Island, Northwest Territories. *Canadian Field-Naturalist* 91(3): 299.

In mid-July 1976 Harold Wright of Holman found the tusk and cranium of a narwhal near Hinigyoak (71°22' N; 117°21' W), a long point on the north shore of Prince Albert Sound. The specimen was partially covered by gravel but very close to the edge of the water.

Length of the maxilla was 53 cm; the total length of the skull measured in a straight line was 61.5 cm. The external length of the tusk while in the skull measured 113 cm from tip to base. From this it can be deduced that the specimen was probably a male animal (3% of females have tusks) with an approximate age of 7–8 years, as determined by the tusk length (K. Hay, personal communication, Arctic Biological Station, Ste-Anne-de-Bellevue, Quebec).

The narwhal occurs regularly in the Lancaster Sound, Barrow Strait, and east Baffin areas of the

Canadian Arctic (Mansfield, A. W., T. G. Smith, and Brian Beck. 1975. The narwhal, *Monodon monoceros*, in eastern Canadian waters. *Journal of the Fisheries Research Board of Canada* 32(7): 1041–1046). The rare occurrence of narwhals along the Alaskan coast especially east of Point Barrow has also been reported (Geist, O. W., J. L. Buckley, and R. H. Manville. 1960. Alaskan records of the narwhal. *Journal of Mammalogy* 41(2): 250–253). No previous records are known for the western Canadian arctic areas of the southern Beaufort Sea and Amundsen Gulf. The natives of the Holman area were questioned but none recalled ever having seen live or dead narwhals.

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Distribution of Stream Salamanders in Southwestern Quebec

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Weller, Wayne F. 1977. Distribution of Stream Salamanders in southwestern Quebec. *Canadian Field-Naturalist* 91(3): 299–303.

Abstract. Two-lined Salamanders (*Eurycea bislineata*), Spring Salamanders (*Gyrinophilus porphyriticus*), and Dusky Salamanders (*Desmognathus fuscus*) were collected at 42 of the 71 localities searched in southwestern Quebec. Most of the distributional records presented considerably extend the known range of these species in this area of the province. Larvae were found under rocks and debris in pools and at margins of streams that drain gravel slopes. Metamorphosed individuals were found at the margins of these streams, and in nearby damp situations.

Three species of aquatic, plethodontid salamanders occur in southwestern Quebec. *Eurycea bislineata*, the Two-lined Salamander, is a wide-ranging species known from the international border to the tip of the Gaspé Peninsula in the east, to near Anticosti Island north of the St. Lawrence River; *Gyrinophilus porphyriticus*, the Spring Salamander, is known only from extreme southern Quebec near the international border; and *Desmognathus fuscus*, the Dusky Salamander, is known only from south of the

St. Lawrence River as far north as the base of the Gaspé Peninsula (see Conant 1975). Distributional maps showing individual localities for these species in papers by Bleakney (1958), Logier and Toner (1961), Mittleman (1966), Brandon (1967), and Pendlebury (1973) show that documented records in this area of Quebec are few, and that the ranges of these species appear discontinuous. These maps do show, however, that all records of *Eurycea* and *Gyrinophilus* are from the Appalachian Mountain system, and that records

of *Desmognathus* are from the Appalachian and Adirondack Mountain systems, and from the Monteregian Hills (Dresser and Denis 1944) on the St. Lawrence Lowlands. Some of these hills do have stream habitats which are like those in the mountain systems of the province which have yielded these species. No stream salamanders have yet been found at localities in the comparatively level, agricultural areas of the St. Lawrence Lowlands.

In this paper, I summarize the known distribution of these species in southwestern Quebec, report new localities, and discuss the occurrence of larval and metamorphosed individuals within the streams, and the habitats in which salamanders were, and were not found.

Collecting Localities and Species Accounts

A search for *Eurycea*, *Gyrinophilus*, and *Desmognathus* was conducted at 71 localities in southwestern Quebec between 27–28 May 1972, 28–30 September 1972, and 15–17 August 1975. I spent from 15 to 30 min at each locality searching under debris in stream pools and ponds, under debris in shallow water and at stream and pond margins, and under debris up to 5 m from the shorelines.

Salamanders (131 *Eurycea*, 6 *Gyrinophilus*, and 48 *Desmognathus*) were taken from 42 localities. These have been deposited in the herpetological collection of the National Museum of Natural Sciences, Ottawa.

TWO-LINED SALAMANDER (*Eurycea bislineata*)

Eurycea was collected at 38 localities in southwestern Quebec (Figure 1). Most localities are within the Appalachian Mountain system; however, four are from the Adirondack Mountains, and one from Rougemont. Larvae were taken from beneath rocks and debris both in stream pools and at the stream margin, and metamorphosed individuals from beneath rocks and debris in damp situations near stream and pond shorelines.

SPRING SALAMANDER (*Gyrinophilus porphyriticus*)

Gyrinophilus larvae were collected at three localities, and observed at one other (most northerly solid square in Figure 1) in southwestern Quebec. Individuals were taken from under rocks and debris in the deep pools of cool, fast-flowing, rocky streams at localities within the Appalachian Mountain system, and at Yamaska Mountain.

DUSKY SALAMANDER (*Desmognathus fuscus*)

Desmognathus was collected at 13 localities in southwestern Quebec (Figure 2). With the exception of the locality at Yamaska Mountain, all are within the Appalachian system. Larvae were found under

rocks and debris in the pools of pastureland and woodland streams. Metamorphosed individuals were found under rocks only at the margins of these same streams.

Discussion

Most of the localities reported in this paper constitute an extension of the known range for all three species in southwestern Quebec. The collection of *Eurycea* from those localities within the Appalachian Mountain system strongly suggests that this species is continuously distributed south of 46°N in that area. The records from the Adirondack Mountains represent the first documentation of this species from this mountain system in Quebec. C. A. Campbell (unpublished) has since collected *Eurycea* from near Franklin Centre in the foothills of the Adirondack Mountains. Denman and Lapper (1964) reported that *Eurycea* has been taken from Mont St.-Hilaire in the St. Lawrence Lowlands, but Denman (personal communication) reports that the specimens were misidentified, and were probably specimens of *Desmognathus*. The collection was in the Redpath Museum of McGill University, but has since been lost or destroyed. The collection made by the author from Rougemont thus represents the first record of *Eurycea* from any of the Monteregian Hills.

The range of *Gyrinophilus* is now known to be more extensive along the margin of the Appalachian Mountain system. The record from Yamaska Mountain represents the first record from any of the Monteregian Hills.

This paper reports several occurrences of *Desmognathus* from several localities distant from those presented by Pendlebury (1973). My records represent the first records from the Lake Mégantic Range of the Appalachian system, and confirms the report by I. S. Lapper to Pendlebury (1973) that *Desmognathus* occurs on Yamaska Mountain. C. A. Campbell (unpublished) has since collected *Desmognathus* from one other locality in the Adirondack Mountains of Quebec.

Salamanders of these species were not found at a number of locations both on the St. Lawrence Lowlands and within the Adirondack and Appalachian Mountain systems (see Figure 2). The water courses at these were generally of three types: (1) large, slow-moving, silty rivers that flow through cleared land, and that do not locally drain heights of land, (2) small, shallow, probably temporary, rocky streams that transect farmland, and (3) farmland ponds and streams extensively used by cattle. These habitats are not at all like those from which specimens were collected. Stream salamanders were found in rocky woodland streams that drained gravel slopes.

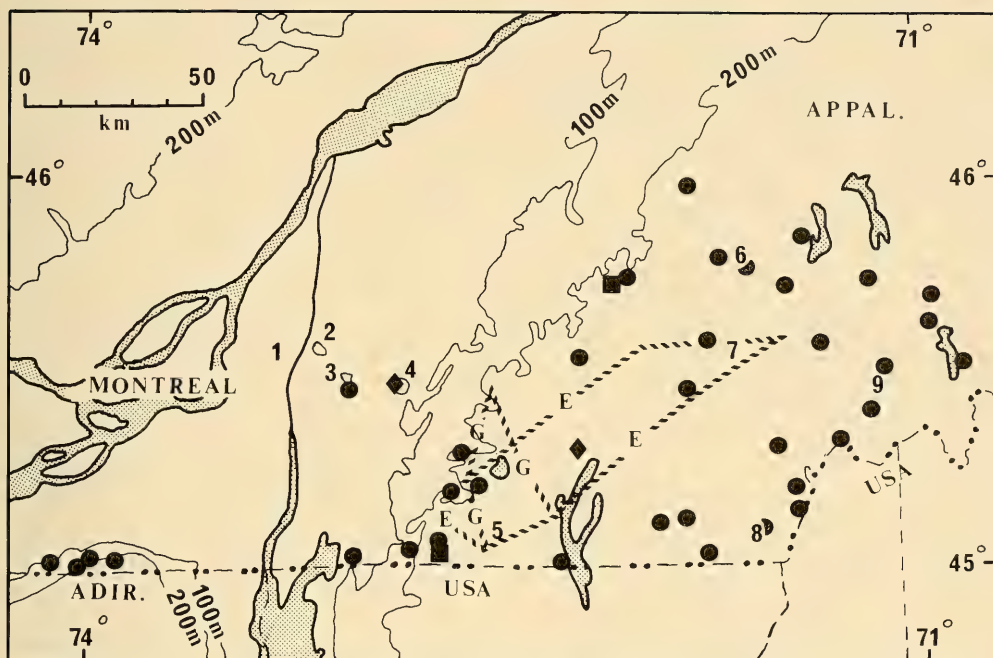


FIGURE 1. Distributional records of *Eurycea* and *Gyrinophilus* in southwestern Quebec. Solid circles represent localities at which the author collected only *Eurycea*; solid diamonds, only *Gyrinophilus*; solid squares, both species. The limits of the known range of *Eurycea* (hatched line "E") and of *Gyrinophilus* ("G") in southwestern Quebec are based upon Bleakney (1958), Logier and Toner (1961), and National Museum of Natural Sciences (Herpetology Section) collections. Four mountain peaks on the St. Lawrence Lowlands (1, St. Bruno Mountain; 2, St. Hilaire Mountain; 3, Rougemont; and 4, Yamaska Mountain) and five peaks or mountain ranges within the Appalachian Mountain system (5, Sutton Mountains; 6, Ham Mountain; 7, Stoke Mountains; 8, Hereford Mountain; and 9, Mégantic Mountain) are presented as landmarks. Adir. and Appal. refer to the Adirondack and Appalachian Mountain systems, respectively.

Gyrinophilus, in particular, was found only in streams that had deep permanent pools.

The occurrence of stream salamanders on St. Bruno Mountain is an enigma. The one specimen, tentatively identified as *Desmognathus* (see Pendlebury 1973), is the only record of aquatic plethodontid salamanders from this hill. Denman (personal communication) has collected extensively on St. Bruno over the years and has never seen salamanders of these species. On 17 August 1975, the author searched for 2 h without success along the southeast slopes of St. Bruno Mountain. Although the streams drained topographic heights in forested areas, they were generally small, silt-laden, devoid of extensive rock cover, and were probably seasonal.

The known distribution of *Eurycea*, *Gyrinophilus*, and *Desmognathus* in southwestern Quebec has been significantly broadened with the records reported in

this paper. It is clear, however, that more distributional records are required before the zoogeography and limiting distributional factors can be understood. Specifically, efforts should be directed towards determining the occurrence of stream salamanders on the Monteregian Hills, if the distribution of *Eurycea* and *Desmognathus* is continuous from north of 46°N to the Gaspé Peninsula, and if *Gyrinophilus* is present in the Adirondack Mountains of Quebec.

Specimens Examined

The localities are listed from west to east, and north to south as presented in Figures 1 and 2. Numbers refer to National Museums of Canada catalogue numbers, and, in parentheses, number of specimens.

Eurycea bislineata. Huntington Co., 2.1 km south and 2.4 km west of Herdman, 17076(1); 6.2 km west of Franklin Centre, 14543(4); 1.5 km south and 6.9 km east of Herdman,

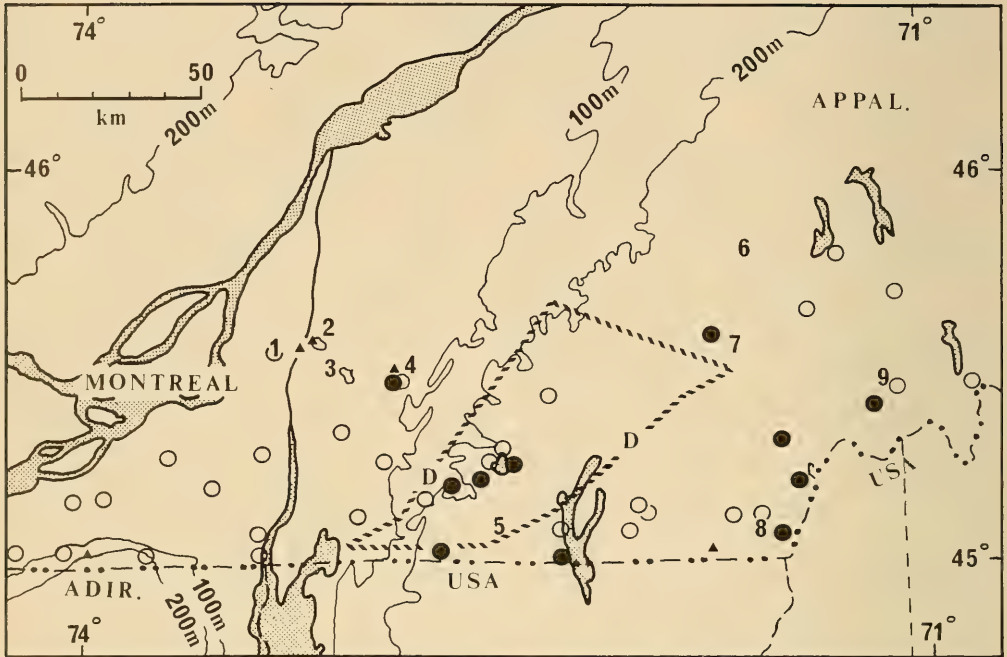


FIGURE 2. The localities at which the author collected *Desmognathus* in southwestern Quebec are represented by solid circles. Hollow circles represent localities at which no stream salamanders were found. The small solid triangles represent localities and the hatched line designated "D," the limit of the known range of *Desmognathus* in southwest Quebec, based upon Pendlebury (1973). Numbers representing mountain peaks or ranges, and abbreviations as in Figure 1.

17066(2). Chateauquay Co., 1.3 km south and 2.8 km east of Franklin Centre, 17083(2). Rouville Co., Rougemont, 17058(10). Missisquoi Co., St. Armand Station, 17059(3); Frelighsburg, 17075(7); 8.0 km east of Frelighsburg, 17071(1); 1.0 km north and 4.6 km west of Abercorn, 17064(3). Brome Co., 2.5 km east of Sweetsburg, 14546(2); 1.8 km south and 0.6 km east of West Shefford, 14561(1); 1.1 km south and 0.9 km west of Iron Hill, 14549(5); 8.5 km south and 2.8 km east of Vale Perkins, 17061(1). Richmond Co., 1.9 km north and 1.1 km east of Racine, 14557(2); 6.1 km north and 3.7 km east of Richmond, 14562(6); 4.2 km south and 2.2 km west of Danville, 14564(2). Stanstead Co., 1.6 km south and 9.7 km west of Coaticook, 17082(6). Arthabaska Co., 7.5 km north and 9.6 km west of Ham-Nord, 14555(7). Richmond Co., 1.6 km north and 6.5 km west of Ascot Corner, 17069(1). Stanstead Co., 0.7 km south and 4.0 km west of Coaticook, 17070(1); 10.2 km south and 1.5 km east of Coaticook, 14550(4). Richmond Co., 5.8 km north and 6.0 km east of Stoke Centre, 17079(2). Wolfe Co., 3.0 km north and 7.1 km east of Wotton, 17049(3); 1.1 km north and 1.8 km west of Ham-Sud, 17055(1). Compton Co., 1.8 km south and 9.9 km east of St. Hermenegilde, 17072(1); 3.3 km north and 1.3 km west of St. Isidore, 17074(17). Wolfe Co., 2.2 km north and 1.1 km west of Weedon, 17053(5). Compton Co., 2.6 km east of St. Malo, 17068(2). Wolfe Co., 6.6 km south and 7.2 km west of Disraeli,

14554(2). Compton Co., 3.6 km north and 1.0 km east of Paquette, 17081(1); Gould, 17051(6); 1.8 km north and 6.2 km west of Emberton, 17054(2). Frontenac Co., 5.8 km south and 6.9 km east of Stratford Centre, 14563(2). Compton Co., 6.6 km east of La Patrie, 17077(1); 4.9 km west of Val-Racine, 17052(3). Frontenac Co., 5.4 km north and 7.4 km west of Lake Mégantic, 14553(5). Compton Co., 2.6 km south and 2.5 km west of St. Samuel Station, 17050(4). Frontenac Co., 8.0 km south of the town of Lake Mégantic, 14556(3).

Gyrinophilus porphyriticus. Rouville Co., 4.5 km south and 2.4 km east of St. Pie, 17056(1). Missisquoi Co., 1.0 km north and 4.6 km west of Abercorn, 17063(2). Stanstead Co., 2.8 km north and 5.9 km west of Magog, 14547(3). Richmond Co., 6.1 km north and 3.7 km east of Richmond, sighting.

Desmognathus fuscus. Huntington Co., 6.2 km west of Franklin Centre, 14542(10). Rouville Co., 4.5 km south and 2.4 km east of St. Pie, 17057(7). Missisquoi Co., 1.0 km north and 4.6 km west of Abercorn, 17065(1). Brome Co., 2.5 km east of Sweetsburg, 14544(7); 1.1 km south and 0.9 km west of Iron Hill, 14548(1); 4.0 km north and 1.5 km east of Knowlton, 14545(1); 8.5 km south and 2.8 km east of Vale Perkins, 17062(2). Stanstead Co., 10.2 km south and 1.5 km east of Coaticook, 14551(3). Richmond Co., 5.8 km

north and 6.0 km east of Stoke Centre, 17080(2). Compton Co., 3.3 km north and 1.3 km west of St. Isidore, 17073(1); 2.8 km west of East Hereford, 17060(11); 2.6 km east of St. Malo, 17067(1); 6.6 km east of La Patrie, 17078(1).

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The River Otter (*Lutra canadensis*) on the North Slope of the Brooks Range, Alaska

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Magoun, Audrey J. and Patrick Valkenburg. 1977. The river otter (*Lutra canadensis*) on the north slope of the Brooks Range, Alaska. Canadian Field-Naturalist 91(3): 303-305.

We believe a case can be made for the range extension of the river otter (*Lutra canadensis*) onto the north slope of the Brooks Range in Alaska within the last two decades (see Figure 1). To our knowledge, the first observation of otters north of the Brooks Range was a report of tracks on the Kuparuk River in 1949 (Bee and Hall 1956). The first recorded sighting of an otter was at Kanayut Lake about 24 km northeast of Tolugak Lake in 1950 (Rausch 1950). Rauch believed the otter was not a resident in the Anaktuvuk Pass region of the Brooks Range; at the time of his investigations, few Inuit there had ever seen an otter. To the east, the people of Arctic Village frequently trapped otters 48 km south of their village, but they had no knowledge of otters occurring in the mountains (Rausch 1953). An otter sighted on the Sheenjek River near the mouth of Old Woman Creek, however, indicated that otters occurred north of the

village at least occasionally, but the observer had never seen otters on the north side of the mountains (Bee and Hall 1956).

By 1965 it appeared that the river otter had become established on the north slope of the Brooks Range. Gubser (1965) reported that the Inuit at Anaktuvuk Pass now considered the otter a resident species in the Chandler River just north of the Brooks Range. David Snarski and Roland Quimby (personal communication) observed otter tracks along Spring Creek on 3 May 1972 and at Shublik Springs on 16 May 1972. On 13 June 1972 we photographed three otters swimming in a small lake about 6 km east of the junction of Eagle Creek and the Canning River. David Snarski (personal communication) saw an otter near open water on the Ribdon River 21 April 1973. Another otter was sighted 22 May 1973 in the Marsh Fork of the Canning River (Jakimohuk 1974). In

April 1974 Audrey Magoun and Averill Thayer saw 17 sets of otter tracks while they were conducting a wildlife survey from Arctic Village north to Shublik Island in the Canning River and west to Elusive Lake (Figure 1). Tracks were evident at nearly every stretch of open water, not only on the south side of the Brooks Range but on the north side as well. While flying over the March Fork Harold Downing saw three otters on 2 May 1975 (Chapman³). Otter tracks were frequently seen in the same area during June 1975.

It is difficult to document range extensions on the north slope of the Brooks Range owing to the paucity of biological information about this area prior to 1950. Otters did occur north of the mountains occasionally, but the evidence suggests they were not

resident there. The increase in sightings of river otters and their tracks could merely correspond to an increase in biologists and other observers. We believe, however, an actual range extension of the river otter has occurred.

Records: (1) Kuparuk River, 70°11'30" N, 149°03'00" W (as reported by Bee and Hall 1956); (2) Kanayut Lake, 68°20'00" N, 151°10'00" W (Rausch 1950); (3) Spring Creek, 68°37'30" N, 149°09'00" W (tracks observed by Roland Quimby and David Snarski on 3 May 1972); (4) Shublik Springs, 69°29'30" N, 146°00'00" W (tracks observed by Roland Quimby and David Snarski on 16 May 1972); (5) Small lake near the mouth of Eagle Creek, 69°23'30" N, 145°52'00" W (three otters observed by Audrey Magoun and Patrick Valkenburg on 13 June 1972); (6) Ribdon River, 60°33'00" N, 148°10'00" W (otter observed by David Snarski on 12 April 1973); (7) Marsh Fork, 69°03'00" N, 146°06'00" W (Jakimchuk

³Chapman, R.C. 1976. The effects of human disturbance on wolves. Alaska Cooperative Park Studies Unit, University of Alaska, College, Alaska. Unpublished report. 154 pp.

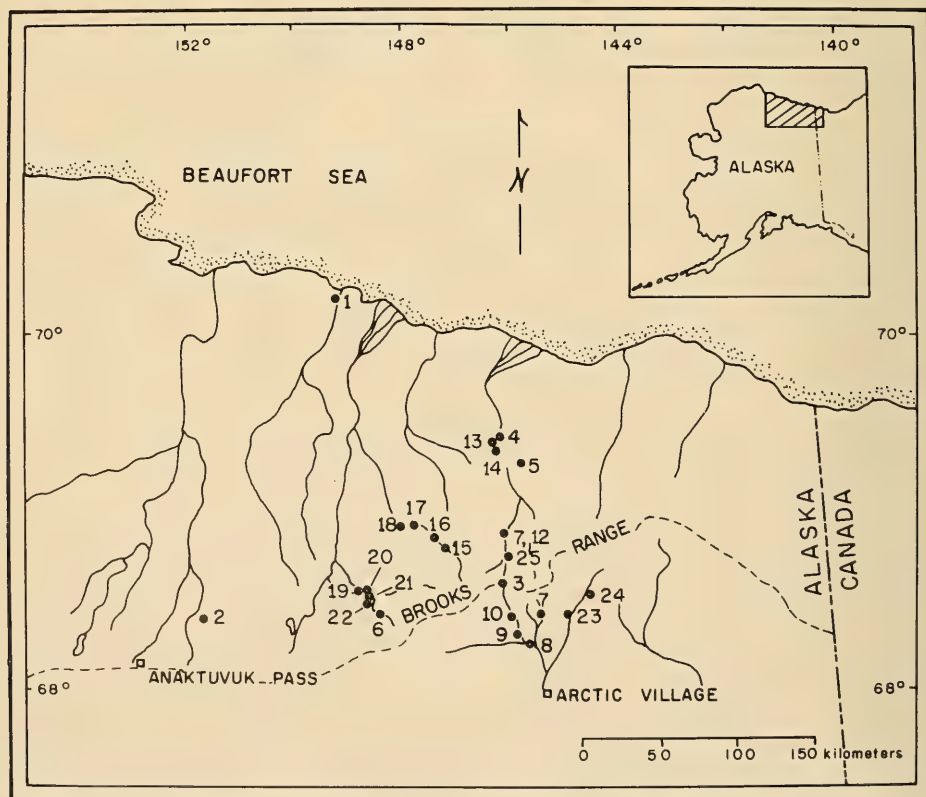


FIGURE 1. Occurrence of *Lutra canadensis* on the north slope of the Brooks Range, Alaska.

1974); (8,9,10,11) Junjik River, 68°33'24" N, 145°32'46" W; 68°23'24" N, 145°43'34" W; 68°26'04" N, 145°54'20" W; 68°30'24" N, 146°07'50" W, respectively (tracks observed by Audrey Magoun and Averill Thayer in April 1974); (12) Marsh Fork, 69°03'00" N, 146°06'00" W (tracks observed by Audrey Magoun and Averill Thayer in April 1974); (13,14) Canning River, 69°27'52" N, 146°16'23" W; 69°26'12" N, 146°14'33" W, respectively (tracks observed by Audrey Magoun and Averill Thayer in April 1974); (15,16,17,18) Ivishak River, 68°55'30" N, 147°04'21" W; 69°01'49" N, 147°18'21" W; 69°02'31" N, 147°33'27" W; 69°01'51" N, 147°42'33" W, respectively (tracks observed by Audrey Magoun and Averill Thayer in April 1974); (19,20,21,22) Ribdon River, 68°39'00" N, 148°25'21" W; 68°39'00" N, 148°16'50" W; 68°37'18" N, 148°15'24" W; 68°35'48" N, 148°11'12" W, respectively (tracks observed by Audrey Magoun and Averill Thayer in April 1974); (23,24) East Fork of the Chandalar River, 68°35'41" N,

144°58'00" W, 68°41'00" N, 144°46'11" W, respectively (tracks observed by Audrey Magoun and Averill Thayer in April 1974); (25) Marsh Fork, 68°53'30" N, 146°07'30" W (Chapman³).

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Lichens of the Bamfield Marine Station, Vancouver Island, British Columbia

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Abstract. Seventy-four species of lichens were collected from the 0.73-km² reserve of the Bamfield Marine Station on the west coast of Vancouver Island. New records for North America were *Buellia griseovirens*, *Caloplaca thallincola*, *Ochrolechia androgyna* var. *saxorum*, and *Porina chlorotica* var. *persicina*. In addition, *Spilonema revertens* is new to the British Columbia flora. The species found indicate the richness of the flora and the need for a more detailed study of the area.

The lichens of British Columbia have only recently been catalogued by Otto and Ahti (1967). Little is known about the lichen flora of southern Vancouver Island (Bird and Bird 1973) and the west coast lichens in general. It was decided that a lichen study of the Bamfield area, where a marine biological station is situated, would be of value, not only to those using the research station, but also to those working on coastal lichens elsewhere in British Columbia. It would provide an indication of the richness of the lichen flora, which in turn might stimulate further studies.

The remote settlement of Bamfield (48°54' N,

125°09' W) lies on the west coast of Vancouver Island approximately 145 km (90 mi) north of the provincial capital of Victoria. To the north of the settlement is the Bamfield Marine Station which is surrounded by a small reserve with an area of 0.73 km² (Figure 1).

Climate

The Bamfield climate, according to the Köppen classification, is equable mesothermal humid and can be considered "oceanic" in the strict sense. The moderating influence of the ocean creates year-round mild temperatures. The highest annual temperature and lowest rainfall occurs during the summer (Table 1). Winter months are characterized by the heaviest annual rainfall with the lowest annual temperatures. Approximately 36 cm of snow falls in a

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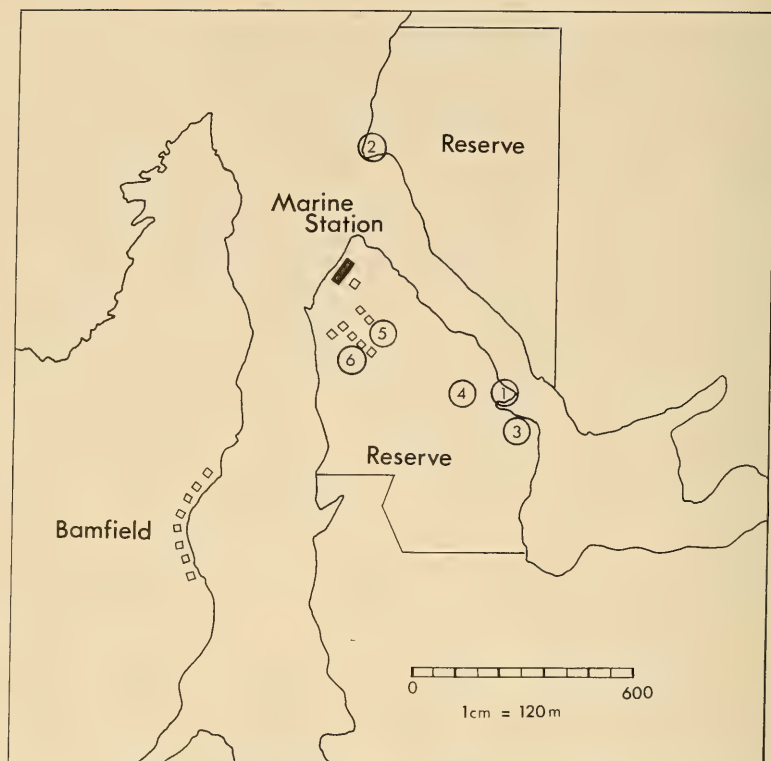


FIGURE 1. Location of the six lichen collection sites in the Bamfield Marine Station Reserve.

year, half of which comes in the month of January. The number of days per year which have measurable precipitation is 162, and the mean annual rainfall is about 280 cm (110 inches).

Geology

Bamfield is situated on the west coast of Vancouver Island. Thirteen kilometres east of the settlement, the mountains of the Somerset Range rise gently from the relatively low relief of the coastline. Much of the coast is less than 50 m high, interrupted irregularly by knolls and bluffs. These hills are composed of intrusive igneous rock, and the flatter areas are underlain by soft sediments. The reserve area includes

beach outcrops of diorite and granodiorite. These rocks are from the Upper Jurassic and Lower Cretaceous. Beale diorite, which is a quartz-bearing diorite, was the substrate for the two shore transects.

In the Bamfield area the prevailing soil processes include strong podzolization, moderate gleization, and very weak laterization.

Vegetation

Climax forest of the Bamfield area is characterized by the association of *Tsuga heterophylla* (western hemlock), *Abies amabilis* (Amabilis fir), *Vaccinium alaskaense* (huckleberry), and the moss *Plagiothecium undulatum*. This type of vegetation is included in

TABLE 1 — Mean monthly temperature and precipitation at Bamfield, British Columbia from 1941 to 1970 (Anonymous 1971)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Temp., °C	1	5	7	10	13	15	19	17	14	9	7	4
Precip., cm	36.6	33.3	30.2	20.9	9.4	7.6	6.3	7.4	14.4	33.8	40.1	41.3

the Coastal Western Hemlock Zone, a section of the Pacific Coast Mesothermal Forest, as described by Krajina (1965). As the annual precipitation is over 280 cm per year, the type of vegetation is placed in the wet subzone. It is a true temperate rain forest with moss-covered trees and abundant epiphytic ferns. This vegetation was previously classified as the "Hemlock-Balsam Climatic Type" (Whitford and Craig 1918), the "Southern Coast C-2 Section" (Halliday 1937), and the "Southern Pacific Coast C-2 Section" (Rowe 1959).

Alnus rubra (red alder) and *Acer macrophyllum* (broadleaf maple) also occur in the study area. *Thuja plicata* (western red cedar) is another common tree and has the distinctive bifurcate leader not found in trees growing farther inland.

Materials and Methods

Specimens were collected in eight different localities (see Figure 1). Sites 1 and 2 were transect samples taken on rocky shores. Location 1 was the base of the trail leading from Grappler Inlet to the marine station road. Site 2 was on a rocky point immediately north of the station. A shady rockface (2b) and a low shrubby area (2c) were also sampled. Bush and rock surfaces in the proximity of the fish trap in Grappler Inlet constituted location 3. Corticolous samples were taken from *Thuja plicata* at the side of the trail leading to Grappler Inlet (site 4), the *Alnus rubra* by the cabins and by the station dump (site 5), and branches of *Acer macrophyllum* near the cabins (site 6).

Specimens are deposited in the National Herbarium of Canada, Ottawa, Ontario (CANL) or the University of Victoria Herbarium, Victoria, British Columbia (UVIC).

Results and Discussion

The lichens recorded from the Bamfield area are listed below by collection site. The taxa marked with a single asterisk are new records for North America and those with two asterisks are new records for British Columbia. Of particular interest was one puzzling specimen of *Lecanora* and a common *Caloplaca* from the littoral zone. Another lichen subsequently proved to be a "chimera" involving *Peltigera aphthosa* (with green algae) and a thallus with blue-green algae. The subject of lichen chimeras has recently been reviewed by James and Henssen (1976).

The lichen flora on old maple trees in the Bamfield area is very luxuriant, including many conspicuous species such as *Sticta crocata*, *Pseudocyphellaria anthraspis*, *Lobaria* spp., and *Usnea* spp. It was not feasible to collect from the tops of the tall coniferous trees but a recent study by Pike et al. (1975) in Oregon suggests that many of the large foliose species recorded from the maples should be found there.

The high rainfall and mild climate of the Bamfield area no doubt favor the development of a very luxuriant epiphytic lichen flora. The most interesting species collected came from the supralittoral zone of the seashore and were saxicolous crustose lichens.

The results of the present study suggest that the lichen flora of the west coast of Vancouver Island is extremely rich and is worthy of further investigation.

Annotated List of Species

Abundance: R = rare, O = occasional, C = common, A = abundant.

Site 1. Sheltered inlet including a rocky intertidal zone.

*Arthopyrenia halodytes*⁵ (Nyl.) Arn. (C) #15 and #17.

Caloplaca sp. (O) #5. This saxicolous lichen from the upper littoral zone has a dark gray thallus and dark orange apothecial discs with dark gray margins. It is common in the same community all along the rocky coast of the Queen Charlotte Islands (British Columbia) and must be widespread. It resembles *C. cerina* (Ehrh.) Th. Fr. var. *chlorina* (Flot.) Müll. Arg. but has a smoother thallus and different ecology (exposed littoral vs. shaded moist rocks); however, it may be a morphotype of this taxon. *Caloplaca cerina* var. *chlorina* has not been reported from British Columbia.

**Caloplaca thallincola* (Wedd.) Du Rietz (O) #6. This lobate *Caloplaca* is quite common in the British Isles where it is also a maritime species associated with *Verrucaria maura* (Duncan 1970). It is a species of the north- and west-European coasts (Poelt 1969).

Lecanora sp. (O) #11. This material appears to be in the *Lecanora subfusca* group close to *L. campestris* (Schær.) Hue morphologically, but its C+ orange thallus cortex (probably containing a xanthone) more closely ties it to *L. fugiens* Nyl. with regard to chemistry.

Parmelia saxatilis (L.) Ach. (A) #1.

***Spilonema revertens* Nyl. (O) #7 and 4. As in Europe, this species apparently is widely distributed in the north, but largely overlooked (see Poelt 1969). It has been reported by Ahti (1964) from a lakeshore in the southern boreal zone of Ontario, and by Thomson et al. (1969) from an open black spruce forest near Great Slave Lake (Northwest Territories).

Sticta weigeli (Ach.) Vain. (O) #2.

Verrucaria maura Wahlenb. ex Ach. (A) #9 and 3.

Site 2. Exposed rocky point north of marine station.

(a) *Rocky Shore*

Acarospora fuscata (Schrad.) Arn. (O) #28.

Aspicilia cinerea (L.) Körb. (O) #38.

Buellia stellulata (Tayl. in Mack.) Mudd (O) #34.

Caloplaca sp. (O) (See comments above) #30.

Caloplaca marina (Wedd.) Zahlbr. (O) #39.

Caloplaca scopularis (Nyl.) Lett. (O) #37.

⁵Harris (1975) points out that this species is actually not an *Arthopyrenia*. Until the new combination made by Harris in his thesis is validated, we are leaving the name unchanged.

Lecanora muralis (Schreb.) Rabenh. (O) #33.

**Ochrolechia androgyna* (Hoffm.) Arn. var. *saxorum* (Oeder) Vers. (O) #35.

Parmelia stictica (Del.) Nyl. (C) #23.

Physcia adscendens (Th. Fr.) Oliv. (O) #36.

Placopsis gelida (L.) Linds. (C) #27.

Rhizocarpon disporum (Naegeli ex Hepp) Müll. Arg. (C) #26.

Spilonema revertens Nyl. (O) #29.

Stictia weigelii (Isert ex Ach.) Vain. (O) #22.

Verrucaria maura Wahlenb. ex Ach. (A) #41.

Xanthoria candelaria (L.) Th. Fr. (O) #32.

(b) *Shady Rockface on Overhanging Cliff*

Porina chlorotica (Ach.) Müll. Arg. (A) #42. This maritime population on the British Columbia coast differs from European material of the species and may represent a new taxon (Harris 1975). The situation is discussed more fully by Brodo (1976).

Verrucaria maura Wahlenb. ex Ach. (O) #44.

(c) *Low Shrub above High Tide*

Dimerella lutea (Dicks.) Trev. (R) #47 and 55.

Lecania sp. (R) #56. This *Lecania* seems close to *L. nylanderiana* Mass. but differs from that species in having one-septate, constricted spores, larger apothecia, and persistent, thick, thalline margins. The thallus and apothecial discs are C-.

Lepraria incana (L.) Ach. (O) #58 and 64.

Leptogium palmatum (Huds.) Mont. (O) #51.

Lobaria pulmonaria (L.) Hoffm. (C) #48.

Nephroma laevigatum Ach. (O) #45.

Pannaria microphylla (Sw.) Mass. (O) #46.

Peltigera aphthosa (L.) Willd. (O) #57.

Peltigera membranacea (Ach.) Nyl. (A) #49.

Peltigera venosa (L.) Baumg. (O) #52.

Proina chlorotica (Ach.) Müll. Arg. (A) #61 and 59.

**Porina chlorotica* var. *persicina* (Körb.) Zahlbr. (O) #50.

This taxon is generally associated with calcareous rock. A short description of the variety is given by Duncan (1970).

Verrucaria maura Wahlenb. ex Ach. (O) #62.

Site 3. Sheltered inlet overhung by trees, near fish trap on trees or soil.

Alectoria vancouverensis (Gyeln.) Gyeln. ex Brodo & D. Hawksw. (A) #79. This species is most easily distinguished from *A. sarmenosa* by its C+ red medullary reaction (due to olivetoric acid). There are morphological distinctions as well, all discussed by Brodo and Hawksworth (1977).

Bryoria trichodes (Michx.) Brodo & D. Hawksw. subsp. *americana* (Mot.) Brodo & D. Hawksw. (Syn. *Alectoria americana* Mot.) #78 and 79 (A). The segregation of *Bryoria* from *Alectoria* is discussed in detail by Brodo and Hawksworth (1977).

Cladonia chlorophaea (Flörke ex Somm.) Spreng. (A) #71.

Cladonia macilentia Hoffm. subsp. *theiophila* Asah. (C) #72.

Cladonia scabruscula (Del. ex Duby) Nyl. (O) #69.

Cladonia subsquamosa (Nyl.) Vain. (A) #73.

Cladonia transcendens (Vain.) Vain. (O) #74.

Icmadophila ericetorum (L.) Zahlbr. (O) #70.

Lepraria candelaris (L.) Fr. (O) #76.

Peltigera horizontalis (Huds.) Baumg. (O) #68.

Platismatia glauca (L.) W. Culb. & C. Club (R) #67.

Sphaerophorus globosus (Huds.) Vain. (C) #66.

Usnea longissima Ach. (A) #79.

Site 4. Bark of Thuja plicata in coniferous forest.

Calcium subquercinum Asah. (O) #84. This species is discussed by Tibell (1975) who reported it for North America for the first time.

Chaenotheca brunneola (Ach.) Müll. Arg. (O) #85.

Graphis elegans (Borr. ex Sm.) Ach. (O) #86.

Icmadophila ericetorum (L.) Zahlbr. (O) #82.

Lecanactis megaspora (Merr.) Brodo (A) #83. The taxonomy and nomenclature of this species is discussed by Brodo (1976).

Sphaerophorus melanocarpus (Sw.) DC. (R) #80.

Site 5. On bark of Alnus rubra in forest openings.

Arthonia radiata (Pers.) Ach. (O) #139.

Arthothelium cfr. *ilicinum* (T. Tayl.) P. James (O) #87.

The spores of this specimen were darker than is usual for the species. *Arthothelium ilicinum* was first reported for British Columbia by Brodo (1971) but apparently is not uncommon along the coast.

Bacidia friesiana Körb. (O) #135.

**Buellia griseovirens* (Turn. et Borr.) Almb. (O) #117.

Buellia griseovirens is often found sterile and is probably more common than existing collections would indicate. Both this specimen and a Swedish specimen with which it was compared contained norstictic acid (according to crystal tests with KOH + K₂CO₃) which is the basis for the KOH+ yellow-turning-red, PD+ yellow reactions of the soralia. The species is common in Great Britain on smooth-barked trees (Duncan 1970) and is probably a western American - western Europe disjunct like many other species (e.g., *Letharia vulpina*, *Alectoria fremontii*, *Cladonia bellidiflora*, etc.).

Buellia penicula (Tuck.) Hasse (O) #116.

Buellia punctata (Hoffm.) Mass. (A) #94.

Buellia stillingiana J. Stein (A) #138.

Cetrelia cetrarioides (Del. ex Duby) W. Culb. & C. Culb. (O) #107.

Hypogymnia enteromorpha (Ach.) Nyl. (C) #93.

Lecanora cfr. *expallens* Ach. (C) #134. The distribution of *L. expallens* was outlined by Brodo (1976) who reported it for the first time for British Columbia. This particular specimen, however, is aberrant in being esorediate and having broader spores; it may, in fact, represent a different species. The thallus does show the C+ orange reaction characteristic of *L. expallens*.

Menegazzia terebrata (Hoffm.) Mass. (A) #91 and 122.

Micarea melaena (Nyl.) Hedl. (O) #140.

Nephroma laevigatum Ach. (A) #100 and 123.

Parmelia sinuosa (Sm.) Ach. (O) #121.

Parmelia sulcata Tayl. (A) #119.

Parmeliella saubinettii (Mont.) Zahlbr. (C) #103.

Peltigera collina (Ach.) Ach. (C) #106.

Peltigera membranacea (Ach.) Nyl. (A) #99.

- Pertusaria ophthalmiza* Nyl. (C) #92. This species is the one most frequently referred to by North American authors under the name *P. multipuncta* (Turn.) Nyl. Its taxonomy is discussed in detail by Dibben (1974).
Pseudocyphellaria anomala Magn. (C) #115.
Sticta limbata (Sm.) Ach. (O) #113.
Thelotrema lepadinum (Ach.) Ach. (O) #136 and 97.
- Site 6. On bark of *Acer macrophyllum*.
Caloplaca ferruginea (Huds.) Th. Fr. (O) #133.
Lobaria oregana (Tuck.) Müll. Arg. (A) #131.
Lobaria pulmonaria (L.) Hoffm. (A) #132.
Ochrolechia oregonensis Magn. (A) #125.
Pseudocyphellaria anthraxis (Ach.) Magn. (A) #130.
Pseudocyphellaria aurata (Ach.) Vain. (O) #126.
Pseudocyphellaria crocata (L.) Vain. (A) #127.
Sticta fuliginosa (Dicks.) Ach. (O) #129.
Sticta limbata (Sm.) Ach. (A) #124.
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Narwhals (*Monodon monoceros*) Observed near King Christian Island, Northwest Territories

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The narwhal (*Monodon monoceros*) is commonly found in Canadian Eastern Arctic waters, but the peripheral parts of its summer range remain poorly documented (K. Hay, personal communication). Catch records indicate that it regularly occurs in Jones

Sound, but the most westerly catch location is Resolute at 74°41' N, 95°00' W (Mansfield et al. 1975). On 6 September 1976, while flying at 61 m above ground level approximately 340 km northwest of Resolute, Stephen counted 10 narwhals in a patch

of open water enclosed by ice approximately 0.4 km in diameter at 77°20' N, 103°30' W in Maclean Strait between King Christian and Lougheed Islands, District of Franklin. Tusks were clearly visible on a number of the animals, thus confirming the identification.

From published records it appears that narwhals penetrate further north into the Arctic than any other cetacean. In the Soviet Arctic, observations have been made between 81°00' N and 84°40' N (Rutilevskii 1958; Tomilin 1967), and schools in the European Arctic have been seen between 82°30' N and 83°00' N (Nansen 1897; Herbert 1969). In Canadian waters, narwhals probably spend the winter in open water in Baffin Bay, and move northward and westward as ice breaks up (Mansfield et al. 1975). Their summer range is centered at northern Baffin Island, but recent summer sight records have also been made around Grinnell Peninsula (Devon Island) and Penny Strait, where their numbers are not large (K. Hay, personal communication). Our record extends the summer range of the narwhal further westward and northward in the Canadian Arctic archipelago.

The observation was made while the authors were

engaged in studies for Panarctic Oils Limited, Calgary, Alberta, whom we thank for permission to publish this note. We are also very grateful to K. Hay and D. E. Sergeant, Environment Canada, Fisheries and Marine Service, Arctic Biological Station, Sainte-Anne de Bellevue, Quebec, for information on Soviet and other records of narwhal distribution.

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A Zone-tailed Hawk in Nova Scotia

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McLaren, Ian A. and Andrew MacInnis. 1977. A Zone-tailed Hawk in Nova Scotia. Canadian Field-Naturalist 91(3): 310-311.

This report gives details of observations of an adult Zone-tailed Hawk (*Buteo albonotatus*) found in the vicinity of Musquodoboit Harbour, Halifax County, Nova Scotia, in autumn 1976. The bird was first seen on 24 September by MacInnis as it quartered along the estuary of the Musquodoboit River, flying over the water, riverside lawns, and clearings. Later in the day MacInnis saw it along a forested hillside. The day was dull and the bird appeared all black. In size and manner it gave MacInnis the impression of being harrier-like. On 25 and 26 September, during MacInnis' absence from the vicinity, it was repeatedly seen near their house on the estuary by Eric Crowell and family, who reported that the bird had a distinctive white tail band. When MacInnis next saw the bird on 29 September he noted this tail band and other features that made him suspect it was a Zone-tailed Hawk. He then contacted McLaren who, along with others, saw the bird several times subsequently. We are thus able to add to our own observations from

field notes kindly given to us by Roger Burrows, Ian MacGregor, Eric Mills, and Wayne Neily.

All sightings were within an area extending about 1 km north, 2 km south, and 3 km east of the town center of Musquodoboit Harbour. The bird was seen, evidently actively searching at times, over shallow water, shores, scrubby fields, semi-cleared hillsides, lawns with and without shade trees, coniferous and mixed woods, and even over the commercial center of town.

The bird was variously stated to be the size (or length) of a Marsh Hawk (*Circus cyaneus*), Red-tailed Hawk (*Buteo jamaicensis*), Rough-legged Hawk (*Buteo lagopus*), and larger than a Broad-winged Hawk (*Buteo platypterus*). Its flight was distinctive. During directed glides its wings were often held horizontally, usually bent at the carpal joint. But when it soared its wings were generally held above the horizontal, sometimes slightly flexed, but more often straight and harrier-like. Its flight when soaring was

rocking and unsteady. When it soared the bird was indeed like a Turkey Vulture (*Cathartes aura*), as pointed out in some field guides; however, three observers familiar with the vulture thought the wing dihedral was not as great in the hawk.

The bird was watched for several minutes on 2 October by McLaren as it worked along 2 km of wooded ridge, about 50–75 m at the summit. It flapped and glided along the ridge in both directions, periodically flapping hard to gain height and then pausing to soar in tight spirals 50–100 m above treetops. Twice it plunged rapidly from such a spiral to inspect or attack (?) something in the trees. The behavior seemed quite unlike that of any of the local raptors.

Two attempts to capture prey were seen: Crowell saw the bird drop "like an Osprey" (*Pandion haliaetus*) into long grass near the estuary; and MacInnis saw it make a rapid feint at a small bird on the top of a roadside tree. Such swift attacks from a bird that soars like, and perhaps mimics, the Turkey Vulture have been commented upon by Willis (1966) and Zimmerman (1976).

Although at a distance the bird appeared all black, many details were evident at ranges that at times were as small as 30 m. Some blackish parts were thought to have a brownish cast by Mills and MacGregor. The broad, grayish-white band across mid-tail was not as marked when the tail was closed, but was as conspicuous as depicted in field guides when the tail was slightly spread. The narrow, grayish-white basal tail bands (seen by five observers who reported two or "at least two") were visible only when the bird was nearby. Only McLaren and Mills reported a dingy terminal tail band.

The paler margins of the underwings, superficially like those of a Turkey Vulture, could not be seen at a distance in poor light. Among field guides for Central and North America, that of Peterson (1961), which shows a gray, not white or grayish-white, ground color of the primaries, seems to portray our bird accurately. Friedmann (1950) described the inner webs of the remiges as paling to deep neutral gray and to grayish white, barred with fuscous black. The fine barring was seen by three observers, and McLaren thought that barring extended to the black underwing coverts, not just part way down the remiges as implied in some field guides. The upper parts appeared to be uniformly dark to some, but Mills observed lighter areas at the base of the primaries and MacGregor and Neily saw the pale mid-tail band from above, perhaps when the tail was more open.

The feet and legs were bright yellow according to all observers, and extended to at least the vent (Mills) or beyond the base of the tail (MacGregor). The legs were dropped briefly for three observers, and the long,

unfeathered tarsi had no bands or jesses (MacGregor). All observers were impressed with the large size and bright yellow color of the cere, seemingly larger than on a number of paintings of the bird consulted by us. On color slides there is a hint of whitish around the yellow on the face; possibly observers were failing to distinguish the cere from pale surrounding feathers.

On 3 October, Crowell obtained a few color slides of the bird, using a 2× teleconverter with a 50-mm lens. The results seem to us to be convincing evidence for the occurrence of this distinctive bird (slides and prints to National Museum of Canada). The bird was seen next day briefly and for the last time by Neily.

The species breeds in the United States only in Arizona, Texas, and New Mexico, and as far as we know strays have occurred only in California and Nevada. It is migratory in northern parts of its range. It can never be known if such an unprecedented bird was a true vagrant or an escaped captive, but the latter possibility can be examined further. Richard Ryan, an American expert on "escapes," writes (personal communication) that he has "personally never seen nor heard of one in the zoo, pet or falconry trade" and that for birds in general "birds of the year constitute 80–90% of recently shipped captives." An escape from the United States or elsewhere in Canada would involve subsequent disoriented flight to Nova Scotia (as for a stray), so that the possibility of escape in Nova Scotia is more likely. We know of no falconers in Nova Scotia, and the bird has not been kept in our "wildlife park" at Shubenacadie (L. Pace, personal communication). M. Sellars, Canada Department of Agriculture, informs us that no hawks have been imported via, or legally shipped through, Halifax International Airport in the months prior to our sighting. Although R. Ryan (personal communication) notes that "birds are very, very rarely shipped by boat," we have learned locally that birds are common as shipboard pets. These are checked and quarantined in Halifax, and we learn from E. D. Kay, Department of Agriculture, that inspectors have not seen hawks of any sort among them.

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Summer Use of a Highway Crossing by Mountain Caribou

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Johnson, Donald R. and Michael C. Todd. 1977. Summer use of a highway crossing by mountain caribou. *Canadian Field-Naturalist* 91(3): 312–314.

Abstract. Caribou use of a highway crossing point near Kootenay Pass, British Columbia was monitored with a time-lapse camera during the summer months when highway traffic was heaviest. Caribou approached the crossing on at least 11 occasions throughout the daylight hours, including times of peak traffic flow. The number of approaches declined as the season progressed. Additional approaches undoubtedly occurred during the daylight hours, but these were not recorded by the camera, and during periods of darkness when the camera was inoperative. We conclude that mountain caribou have become habituated to the presence of the highway and road traffic and that they continue to use a traditional movement route despite man-caused harassment and mortality.

Although caribou reaction to newly-placed movement barriers has received recent attention (Miller et al. 1972; Child 1973), little information is available on the reaction of caribou to permanent, man-made obstacles such as a heavily used highway. Klein (1971) briefly mentioned that wild reindeer terminated use of a range area a few years after construction of a main highway and railroad in Norway. Bergerud (1974) has discussed the reaction of caribou to visual, auditory, and olfactory stimuli including man-caused disturbances.

Mountain caribou, *Rangifer tarandus montanus*, have moved across heavily-traveled British Columbia Highway 3 near Kootenay Pass since the highway was completed in 1963. Most caribou have been observed crossing the highway at three locations both east and west of the summit (Freddy 1974, p. 40). Considering topographic features, it is likely that these crossings represent sites at which the highway intercepts traditional movement routes.

Methods

We monitored caribou approaches to one of these crossing points (North Fork of Summit Creek, 4 km east of Kootenay Pass) from 18 June through 23 August 1976 using a time-lapse movie camera in order to determine (1) the number and composition of caribou using the crossing, (2) the time of day the approaches occurred, (3) the pattern and frequency of approaches in relation to traffic flow, and (4) the reaction of caribou to the presence of motorists on the highway.

A Minolta D-6 Super 8-mm movie camera housed in a protective cover was mounted on a tree 5 m above the ground so that it monitored about 0.5 km of highway. The camera was powered by a 6-V rechargeable battery and fitted with instrumentation to regulate automatically exposure rate (Four Seasons Services, Laramie, Wyoming). A light sensor limited the camera operation to daylight hours.

Through use of an exposure rate of 1 frame/minute, 800–1000 frames were exposed daily, depending on day length and cloud cover at dusk and dawn. At this exposure rate, a 3600-frame cartridge of color film (50 ft) was expended in 3.6 to 4.5 days. Because of logistical problems, we chose to monitor the site at weekly intervals rather than continuously. But monitoring occurred during some weekends when traffic was heaviest as well as during weekdays.

Exposed film was examined in a viewer and the presence of caribou and traffic on each frame was recorded. Slow-moving or stopped vehicles were recorded more than once since they represented a continuous disturbance at the site. The time of each approach and its duration were calculated from the time exposure commenced and the exposure rate.

Results and Discussion

During more than 570 h of camera operation, the occurrence of caribou at the crossing was confirmed on 11 occasions (Table 1). In 10 instances these represented either one or two animals; some of these could be identified as bulls, based on body and antler size. The cow-calf band, which has remained in the Summit or Carolina Creek basins during recent summers, was photographed at the crossing on 30 July.

Because of the possibility of repeat approaches by the same individuals, it is difficult to estimate the total number of caribou photographed at the site. Based on body size and the presence or absence of antlers, a minimum of 12 different animals was photographed (two large bulls, seven cows and subadults, three calves). Since the total number of caribou in the West Kootenay band is estimated at 25–30 animals (Johnson 1976), perhaps one half of these were photographed at this traditional crossing during the monitoring period.

Caribou approaches to the crossing occurred throughout the daylight hours (0618–1940 hours),

TABLE 1—Time of day, number and composition of caribou photographed on Highway 3. Only if animals were in certain positions could we see and record whether they were antlered or antlerless

Date	Time	Number and composition
19 June	1140–1142	1 antlered bull
20 June	1158–1621	2 antlered bulls
	1808–1940	2 subadults
25 June	1545	2 subadults
	1746	1 subadult
26 June	0618	1 subadult
	0657–0658	1 subadult
12 July	1248–1252	2 subadults
25 July	1052	1 antlerless cow; 1 calf
30 July	1007–1029	7 adults and subadults; 3 calves
21 August	1806	2 adults, antlerless

including times of peak traffic flow (Figure 1). Caribou usually appeared only briefly within camera view. On 20 June, however, four caribou appeared in 27 frames over a 2-h period (Table 1). On several occasions caribou were photographed while they were licking at the surface of the highway, perhaps at oil spots. Loggers have reported that caribou licked grease fittings on their machinery parked overnight (Layser 1974).

There was a progressive increase in traffic throughout the summer. If we ignore days when stalled vehicles inflated the total, 29% of the frames

exposed in June contained at least one motor vehicle; 36% of those exposed in July and 39% of those exposed in August contained at least one vehicle. There was a progressive decrease in the number of frames containing caribou during the same period. In June, caribou were found in 34 frames during four days; in July they occurred in eight frames during three days; and in August their presence was detected in only a single frame. We believe that this decrease in the use of the crossing by caribou was not related to increased traffic flow since caribou were not deterred from the crossing at times of peak traffic flow (Figure 1). It is more likely that caribou moved to higher elevations as the summer progressed and ground forage became available after snow melt.

Motorists frequently stopped at the crossing because of car trouble, to pick berries, or to view caribou. On several occasions the camera recorded vehicles stopped along the highway and a number of people standing on the shoulder of the road. Caribou were often photographed soon after the motorists moved on. The presence of several stopped vehicles indicated that caribou probably were present along the highway on 27 July and 10 August but no animals were photographed on these days. The limitations of a single camera with a 1-min exposure rate are obvious. We have also confirmed the use of the crossing at night although we do not know if the frequency of use differs between daylight and darkness.

Our direct observation of caribou behavior at the crossing during the summer months indicated that

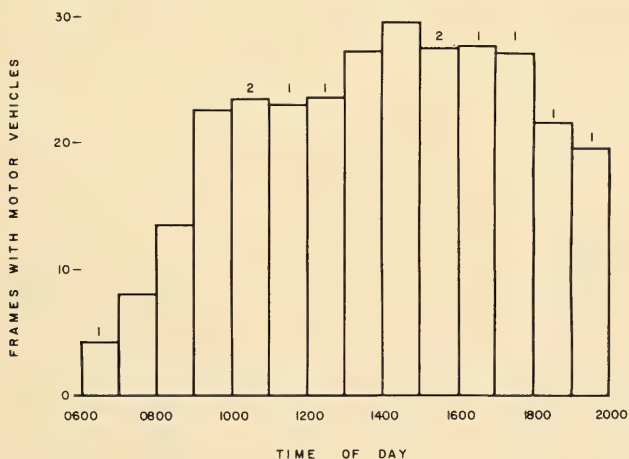


FIGURE 1. Caribou approaches (singly or in groups) to the North Fork Highway Crossing in relation to traffic flow. Numbers indicate approaches within time intervals.

some animals approach the highway with caution and seek cover in the nearby timber if motorists stop to view them. Others remain alert but continue to feed beside the highway or move off slowly in response to the presence of motorists nearby. At least seven caribou have been killed in collisions with motor vehicles since the highway was opened, including a cow and calf in separate incidences at the North Fork Crossing in 1976. Caribou have been shot illegally along the highway (Freddy 1974). Despite this harassment and mortality they continue to cross the highway at what appears to be traditional locations.

Completion of British Columbia Highway 3 through the Kootenay Pass region has fostered the development of a utility corridor along its route including a natural gas pipeline and two power lines (Johnson 1976). Although restriction of these developments to a narrow corridor localizes their environmental impact, the continued increase in the number of these hazards may eventually interrupt the normal north-south movement of caribou in this region. The impact of these developments on caribou movement needs further study.

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Changes in the Avifauna of the West Foxe Islands, Northwest Territories, 1956-1976

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F. G. Cooch. 1977. Changes in the avifauna of the West Foxe Islands, Northwest Territories, 1956-1976. *Canadian Field-Naturalist* 91(3): 314-317.

Abstract. During July 1976, a resurvey was made of the bird populations of the West Foxe Islands near Cape Dorset, Northwest Territories. Three species new to the area were recorded: Great Black-backed Gull, Eastern Kingbird, Yellow-rumped Warbler. Changes in numbers and status of other species since the last survey in 1956 were noted. Heavy snow during the winter of 1975-76 and delayed melt are considered to be causative factors in the changes in numbers of most species.

Macpherson and McLaren (1959) published an annotated list of the birds of the southern Foxe Peninsula, Baffin Island (64° 14' N, 76° 13' W), based on their observations of 1954 and 1955 and those of Cooch in 1955 and 1956 (Cooch, F. G. 1957. Birds observed in the vicinity of Cape Dorset, Baffin Island, in the summers of 1955 and 1956. Typed report, on file National Museum of Canada. 13 pp.).

In the period 8-19 July 1976, while on a resurvey of the Northern Eider (*Somateria mollissima borealis*) populations of the Cape Dorset Migratory Bird Sanctuary, I recorded a number of species new to Cape Dorset, as well as changes in population status of species noted previously. The West Foxe Islands (Figure 1), South Island in Andrew Gordon Bay, and Sakkiak Island near Cape Dorset, were set aside as a

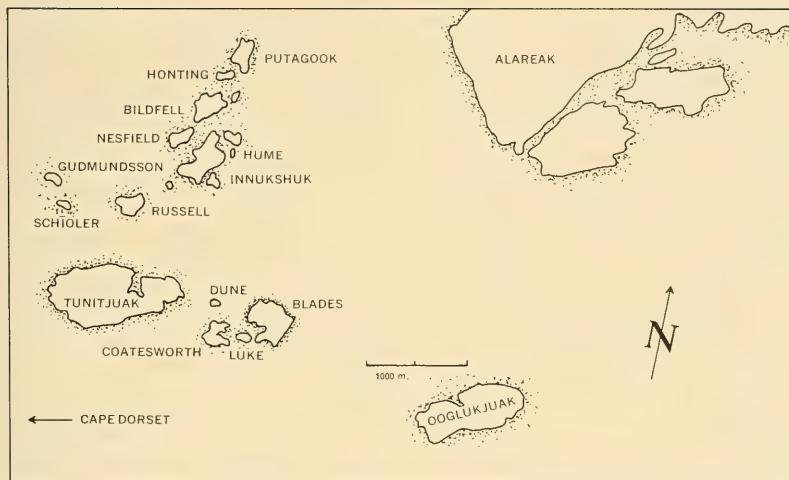


FIGURE 1. West Foxe Islands, Northwest Territories ($64^{\circ}14' \text{ N}$, $76^{\circ}13' \text{ W}$).

Federal Migratory Bird Sanctuary in 1957 to provide protection for eiders.

Spring breakup in 1976 in southern Baffin Island was atypical. May was abnormally warm and the above-normal snowfall began to melt rapidly. The weather changed dramatically in June when high winds, fog, and freezing rain were normal. One result of the high winds was the disappearance of much of the land-fast sea ice before mid-June.

The unusual nature of the spring phenology, the heavy snow cover which persisted in many areas even after 20 July 1976, and the persistence of ice on most inland lakes apparently had a marked effect on the subsequent distribution and migration patterns of birds nesting in the Cape Dorset area and farther north.

The following is a list of birds observed on the West Foxe Islands, 8–19 July 1976, with general comments from the Cape Dorset Area.

COMMON LOON (*Gavia immer*)

Uncommon spring transient 1955; relatively common summer resident 1976. Not known to breed on small tarns on coastal islands. Large inland lakes normally used by this species were still frozen on 18 July 1976. The continued presence of ice on the larger inland lakes must have affected the distribution of all three species of loons normally breeding in the Cape Dorset area.

ARCTIC LOON (*Gavia arctica*)

Uncommon spring transient in 1955 and 1956; relatively abundant — at least 15 individuals were recorded daily in July 1976 among the West Foxe Islands, where they had not been detected in summer in 1955 or 1956.

RED-THROATED LOON (*Gavia stellata*)

Common spring transient in 1955 and 1956; abundant in 1976 in the West Foxe Islands. One nest was located on a 1-ha tarn on Innuksuk Island. Previously not known to breed.

CANADA GOOSE (*Branta canadensis interior*)
(*Branta canadensis hutchinsii*)

The West Foxe peninsula supports two races of Canada Geese, medium-sized form (*B.c. interior*) and a small form (*B.c. hutchinsii*). Usually the latter breeds along the north coast of the Foxe Peninsula from Harkin Bay northeast along the Great Plains of the Koukdjuak to Taverner Bay ($67^{\circ}12' \text{ N}$, $72^{\circ}25' \text{ W}$) whereas the larger race is restricted to the coastal area south of Cape Queen. In 1976 both races nested in the West Foxe Islands where neither had been recorded breeding previously. On 10 July 1976, an intermediate-sized pair with two young approximately 3 days old were found on the top of Luke Island, and on 14 July a pair representing the small race was observed with three young on Blades Island. This is taken as further evidence of displaced nesting in 1976.

ATLANTIC BRANT (*Branta bernicla hrota*)

Cooch (manuscript) recorded a successful nesting attempt by the species on the West Foxe Islands in 1956. At least four pairs attempted to nest there in 1976 and others were reported by Inuit to be nesting at widely scattered locations along the south coast of Baffin Island. The nearest known Brant nesting colony is at Cape Dominion 300 km north of the West Foxe Islands. An apparent change in autumn distribution was reported by Inuit who camp at the head of Andrew Gordon Bay about 80 km east of Cape Dorset. Several thousand Brant are now seen regularly in late August feeding in the sea and along the tidal wrack at the mouth of the Saunders River. This autumnal build-up did not occur in 1955 and 1956 and apparently started only in the late 1960s.

LESSER SNOW GOOSE (*Anser caerulescens*)

Although an abundant spring and autumn migrant through the area along a broad front from Cape Queen east to Markham Bay, it does not normally breed locally. A nest containing parts of three eggs was detected on Dune Island 12 July 1976, and on 14 July 1976 a mixed pair (white phase male–blue phase female) accompanied by a single white phase gosling was seen on nearby Innuksuk Island. Inuit reported this species nesting in non-colonial situations at various places along the south coast in 1976. They had previously noted much displaced breeding in 1972, when the colony area at Bowman Bay was snow-covered into early July, as it was in 1976. They also noted that the peculiar migration pattern of 1972 was repeated at Cape Dorset in 1976. Normally the geese make a rapid straight-line flight from Ungava to the vicinity of Cape Dorset – Andrew Gordon Bay, then turn northeast toward Bowman Bay and the Great Plains of the Koukdjuak. In both 1972 and 1976 significant reverse migrations were observed a few hours after the first flights passed over Cape Dorset. Subsequent flights reaching Cape Dorset appeared confused and veered to the northwest, toward the flat coastal tundra near Cape Dorchester, which was apparently relatively snow-free.

PINTAIL (*Anas acuta*)

Three males were seen on a small lake on Blades Island 13 July 1976. The species is not normally found in the Cape Dorset area. Northward post-breeding dispersal of males of the species is a widespread phenomenon.

NORTHERN EIDER (*Somateria mollissima borealis*)

After the Black Guillemot, this is the most abundant species nesting in the West Foxe Islands. Estimates of breeding pairs on the West Foxe Islands were 982 in 1955, 1295 in 1956, and in 1976 only 367 pairs. Almost all of the decrease occurred on Tunitjuak Island where fewer than 50 pairs were found in 1976 compared to 667 in 1955 and 755 in 1956. Although much of this decrease must be attributed to depredations by Inuit taking eggs and shooting female eiders (Cooch, unpublished data), the heavy snow cover of the winter of 1975–76 and the slow thawing of interior lakes were also undoubtedly important factors contributing to the decline of the numbers of eiders on the largest of the West Foxe Islands. Egg-laying effectively ceased on 20 July 1976 (P. Putagook, personal communication), about 4 days later than the previously recorded last date of 16 July 1956.

Predation was unusually heavy because of the numbers of non-breeding Herring Gulls, Glaucous Gulls, and Parasitic Jaegers.

OLDSQUAW (*Clangula hyemalis*)

An abundant spring migrant but normally an uncommon summer resident. Several flocks of up to 25 birds were seen daily in July 1976. At least three pairs of Oldsquaws nested on the inner West Foxe Islands in 1976; none had been recorded breeding in 1955 or 1956.

SEMIPALMATED PLOVER (*Charadrius semipalmatus*)

This most abundant species of shorebird breeding in the sanctuary is found primarily in dry upland lichen and grassy swales. First hatching detected in 1976 was on 16 July on Coatesworth Island. Population numbers were little changed from previous surveys in 1955 and 1956.

PURPLE SANDPIPER (*Calidris maritima*)

An abundant spring and autumn migrant and an uncommon summer resident. Not previously known to breed on the West Foxe Islands. Abundant summer resident in 1976; breeding was strongly suspected on the basis of distraction display by three widely scattered pairs. At least 250 individuals were resident in July 1976 compared to none in July 1955 or 1956.

SEMIPALMATED SANDPIPER (*Calidris pusilla*)

Abundant around tarns in 1955 and 1956 and a common breeding bird. A single individual was seen in 1976, with no evidence of breeding.

PARASITIC JAEGER (*Stercorarius parasiticus*)

Parasitic Jaegers are not known to breed in the West Foxe Islands. In 1955 only a single bird was seen. In 1956, when there was a relatively late spring, more than 150 sightings were made during the period 15 May – 10 September. In 1976 in excess of 200 sightings were made in the period 9 to 16 July alone. The presence of Parasitic Jaegers in numbers on the West Foxe Islands in 1976 is probably related to the non-breeding of Lesser Snow Geese on the Foxe Basin Coast of Baffin Island. A similar increase in numbers was observed in 1956 when snow covered the Great Plains of the Koukdjuak and Southampton Island until 22 June. In years of long-lingering snow, non-breeding of geese, lows in the lemming populations, and lack of suitable nesting habitat, jaegers disperse widely in search of alternative feeding sites.

GREAT BLACK-BACKED GULL (*Larus marinus*)

A single representative of this species was seen at Ooglukjuak Island 14 July 1976. It has been seen increasingly on the Atlantic coast of Baffin Island in recent years (D. N. Nettleship, personal communication), but has not been reported so far west on the south coast.

HERRING GULL (*Larus argentatus smithsonianus*)

In 1955 and 1956, 15 scattered pairs nested on the West Foxe Islands. No nesting was detected in July 1976, although 15–20 birds were seen over the islands at any given time. A communal roost on the east end of Tunitjuak Island is further evidence of non-breeding in 1976. The almost total lack of gulls of any species in the vicinity of Cape Dorset harbor was startling when compared to their abundance in 1955 and 1956.

KUMLIEN'S GULL (*Larus glaucoideus kumlieni*)

The colony at Ooglukjuak (Macpherson and McLaren 1959; Macpherson 1961) numbered 28 breeding pairs on 14 July 1976, plus 24 potential pairs, a net decrease of 50 pairs since the last census on 18 July 1956 (Cooch, manuscript). Of 36 eggs candled, none gave an indication of hatching before 21 July.

THICK-BILLED MURRE (*Uria lomvia*)

In the period 1955–56 Brunnich's Murres, presumably from the vast colony at Digges Island (120 km south of Cape Dorset) were noted in the vicinity of Cape Dorset in a restricted area between Dorset Island and Neta Island 16± km (10 mi) to the east. They were most abundant in May and early June along the edge of the land-fast ice. In 1976, murres, although most common in their traditional area, were seen commonly at least as far east as South Island, Andrew Gordon Bay, approximately 128 km (80 mi) east of

Cape Dorset. This may reflect a poor breeding season at Digges Island or, more probably, the abundance of non-breeding yearlings produced in the excellent 1975 breeding season. Unusually extensive areas of open water occurring throughout the Neta, Shemia, and West Foxe Island chains before 15 June may also have attracted unusually large numbers of murres. At least 4000 birds were in the vicinity of the West Foxe Islands between 9 and 19 July 1976.

BLACK GUILLEMOT (*Cephus grylle ultimus*)

An abundant nesting bird wherever suitable talus or scree slopes are available. The major colony site on Russell Island remained almost completely snow-covered in 1976 until my departure from the islands on 17 July. No young were observed and many clutches contained a single egg or reached their full complement of two during the interval 14–16 July. The peak of hatching was not expected until the second week of August. The long-persisting snow banks which covered many choice talus slopes radically redistributed guillemots throughout the islands, forcing some into inland crevices overlooking freshwater ponds — sites which were not utilized in 1955 or 1956. No overall decrease in the total of guillemots was detected in the West Foxe Islands although the colony on Russell Island was reduced to perhaps 500 pairs, down from the 3000 recorded in 1956.

EASTERN KINGBIRD (*Tyrannus tyrannus*)

A new record for the Cape Dorset area and apparently for Baffin Island. A solitary male was seen feeding on masses of newly hatching mosquitoes on Blades Island 13 July 1976.

WHEATEAR (*Oenanthe oenanthe*)

A nest containing three eggs was discovered in a crevice on a high rocky outcrop on Tunitjuak Island on 14 July 1976. Wheatears are not uncommon on the south coast of Baffin Island, approximately 80 km (50 mi) south of Lake Harbour. Macpherson and McLaren (1959) reported three breeding pairs of Wheatears nest-building at the Aitken Lakes near the Cape Dorset settlement.

YELLOW-RUMPED WARBLER (*Dendroica coronata*)

A new record for the Cape Dorset area and apparently for Baffin Island. A solitary male was seen feeding on mosquitoes not far from the site where the Eastern Kingbird was seen earlier on 13 July 1976.

WATER PIPIT (*Anthus spinoletta*)

A common breeding species in both 1955 and 1956, totally absent in 1976.

COMMON REDPOLL (*Acanthis flammea*)

Common spring migrant, relatively uncommon summer resident in 1955 and 1956. None seen in 1976.

LAPLAND LONGSPUR (*Calcarius lapponicus*)

An abundant breeding species in 1955 and 1956 but virtually absent in 1976 when only one pair and two stray males were seen.

SNOW BUNTING (*Plectrophenax nivalis*)

In 1955 and 1956 Snow Buntings nested abundantly on every island in the West Foxe chain, at densities approaching one pair per hectare. In 1976 this crevice-nesting species was severely affected by long-lingering snow drifts in favored nesting sites and densities dropped to one pair per 10 hectares. A similar lack of Snow Buntings was recorded in the vicinity of Cape Dorset settlement.

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Unusual Predators of Snow Goose Eggs

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Abraham, Kenneth F., Pierre Mineau, and Fred Cooke. 1977. Unusual predators of Snow Goose eggs. Canadian Field-Naturalist 91(3): 317–318.

Several bird and mammal species prey on the eggs of Lesser Snow Geese (*Anser caerulescens caerulescens*). Parasitic Jaegers (*Stercorarius parasiticus*), gulls (*Larus* spp.), and arctic fox (*Alopex lagopus*) are considered the most important predators (Cooch 1958; Ryder 1969a). Less important predators include Sandhill Cranes (*Grus canadensis*) (Harvey et al. 1968), wolves (*Canis lupus*), polar and grizzly bears (*Ursus maritimus* and *U. horribilis*) (F. G. Cooch, Canadian Wildlife Service, personal communication;

Barry 1967). In this note we describe predation on Snow Goose eggs at La Pérouse Bay, Manitoba, by two previously unreported species. La Pérouse Bay is located 40 km east of Churchill, Manitoba.

Caribou (*Rangifer tarandus*) occur near many Snow Goose colonies and are seen regularly at La Pérouse Bay, but have never been reported as goose-egg predators. On 8 June 1976, KFA observed a young caribou walking from island to island in a shallow lagoon where Snow Geese and Common

Eiders (*Somateria mollissima*) nest. Female geese and eiders flushed from nests as the caribou moved within 10 min of the caribou's leaving. For 30 min the female The caribou ate willow (*Salix* spp.) buds and leaves on several islands, but on one it stopped by an active Snow Goose nest that we had marked, pawed at the nest, and appeared to eat something. The nest was checked immediately and five of six eggs were found crushed with little of their contents remaining. During the 5 min the caribou remained at the nest, the attendants could not be identified from among a group of 45 yearlings and adults which gathered near the island, but a pair of Snow Geese returned within 10 min of the caribou's leaving. For 30 min the female poked at the egg remains while the male stood 2 m away. The female was observed to lower, then raise and tip back her head as if drinking, and also to eat some of the eggshells. (Ryder (1969b) discusses the significance of egg-eating by Snow Geese.) The nest was revisited on 10 June and had been partially reconstructed with the intact egg in the bowl. On 15 June the nest was empty; the fate of the last egg is unknown.

On 15 June, KFA observed another young caribou similarly disturb two occupied nests about 3 km away from the location of the first incident, but in a much drier nesting area. Again the geese flushed ahead of the caribou and did not attempt to defend their nests. At the first nest, this caribou rolled the eggs out of the nest bowl with its right foreleg, crushed one and licked the egg, but did not eat the 15- to 20-day-old embryo. It then immediately moved to another nest 50 m away, repeated the sequence but this time picked up and ate one embryo. It continued to walk through the area, but was not seen at any more nests. A nest check showed one crushed and four intact eggs at the first nest, three crushed and two intact eggs at the second nest.

Size and antler characteristics assured us that two different caribou were responsible for these acts of predation. Hunger may have been a motivating factor, but does not by itself explain it as in each case only part of the egg was eaten. As both appeared to be young individuals, perhaps curiosity was partially responsible for this behavior. Kelsall (1968) reviews the miscellaneous foods of reindeer and caribou, which include birds' eggs and possibly nestlings, but stresses the rarity of these events. The reaction of the geese also indicates that caribou weren't recognized as predators, although PM observed geese threatening and charging caribou during late incubation in 1975. We think it unlikely that caribou predation of Snow Goose eggs is of major importance.

To our knowledge black bears (*U. americanus*) have never been sighted at a Snow Goose colony. Two

sightings were made on 22 and 23 June 1975 at La Pérouse Bay, probably involving the same individual. Tracks indicated that several nests had been visited, but all the eggs had already hatched. On 23 June, PM witnessed one incidence of predation. The bear walked to an occupied nest with three eggs which had been incubated at least 16 days. As the bear neared the nest, the gander briefly adopted a high-intensity threat posture with wings extended and head held low before retreating with the female to a shallow stream 15 m away. The bear spent less than a minute at the nest. A subsequent check revealed that two of the three eggs had been eaten, the embryos having been removed from the crushed shells. The third egg was rotten; this may explain why it was not eaten. The goose continued to incubate for 2 days at which time we removed the egg from the nest.

The omnivorous habits of black bears are well documented and they are known to supplement their diet with birds' eggs. Given the present southward expansion of the Snow Goose breeding range (Dzubín et al. Blue and Snow Goose distribution in the Mississippi and Central flyways, Volume 1, Canadian Wildlife Service Report, 1973), and the increasing tendency of black bears to move north of the tree line (Jonkel and Miller 1970), it is possible they will become more frequent predators at the more southern Snow Goose colonies.

A continuing study of Snow Geese at La Pérouse Bay, Manitoba, is funded by the Canadian Wildlife Service, National Research Council, the Canadian National Sportsmen's Show, the Wildlife Management Institute, and the Manitoba Department of Mines, Energy and Environmental Management.

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New and Notable Finds in the Alaskan Vascular Flora

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Halliday, G. 1977. New and notable finds in the Alaskan vascular flora. *Canadian Field-Naturalist* 91(3): 000-000.

Abstract. *Pleuropogon sabinei* R. Br., *Potentilla rubricaulis* Lehm., and *Pedicularis hirsuta* L. are reported for the first time from Alaska; second records are given for *Puccinellia angustata* (R. Br.) Rand. & Redf. and *Colpodium vahlium* (Liebm.) Nevski together with a number of important extensions of range. Twelve species are listed which have not previously been recorded from Prudhoe Bay, on the north-east coast.

Key words: *Pleuropogon sabinei*, *Potentilla rubricaulis*, *Pedicularis hirsuta*, Alaskan flora

The more interesting finds of vascular plants made during a brief visit to Alaska in July 1975 are listed below. Most of the collections were from the following localities.

1. Fairbanks — vicinity of University campus and the airfield (64°50' N, 147°45' W).
2. Livengood (80 km north-west of Fairbanks).
 - (a) East-west ridge north of the Elliott Highway and 55 km south-west of Livengood (65°15' N, 149°30' W),
 - (b) Brown Lake and nearby West Fork of Tolovana River, 13 km south-west of Livengood (65°27' N, 148°40' W),
 - (c) Livengood Dome (65°36' N, 148°30' W).
3. Wickersham Dome (between Fairbanks and Livengood) (65°13' N, 148°05' W).
4. Sourdough Creek (80 km north-east of Fairbanks), north of the Steese Highway, and from head of creek to Point 5043' (65°20' N, 146°30' W).
5. Prudhoe Bay — between Kuparuk River and Sagavanirktok River (70°20' N, 148°30' W).
6. Galbraith Lake (north side of Brooks Range on trans-Alaska pipeline) — limestone hills east of the lake (69°30' N, 149°30' W).

Of these areas one of the most interesting was 2(a). Several montane species were found on this ridge which were not previously known to occur so far west in the mountains between the Yukon and Tanana Rivers. Immediately north of the ridge lies the remote and botanically unknown area around the Wolverine and Sawtooth Mountains, an area which would certainly repay study.

The species are listed as far as possible according to the sequence and nomenclature adopted by Hultén (1968). Herbaria are referred to by their international abbreviations. A set of nearly all the 500 numbers collected is in the Arctic Herbarium at LANC.

Pleuropogon sabinei R. Br.

Prudhoe Bay: north side of the Spine Road just west of Gathering Center-1. 12 July 1975, no. A223/75,

ALA, BM, E, LANC, S. It was growing in bare mud by a small stream only a few yards from the road and associated with *Arctophila fulva*, *Dupontia fisheri*, and *Eriophorum angustifolium*. The population covered only a few square metres and the site had almost certainly been affected to some extent by the construction of the road. The plants were flowering freely.

This is the first record of this species from Alaska. Although the species was mapped by Hultén (1958) as an amphi-Atlantic species, he expressed the opinion that recent finds on Wrangel Island and extreme eastern Siberia, and on Banks Island and Victoria Island, made it a circumpolar species. The Alaskan locality perfectly bridges the remaining gap between these eastern and western limits and vindicates Hultén's (1968) faith in including this species in his Alaskan Flora.

Puccinellia angustata (R. Br.) Rand. & Redf.

Prudhoe Bay: pingo at south-east end of British Petroleum Operations Center reservoir. 9 July 1975, no. A183/75, ALA, CAN, LANC, S. Along the western shore of the Sagavanirktok River estuary and on the adjacent tundra. 11 July 1975, no. A213/75, LANC, S.

At the latter locality *P. angustata* was a conspicuous species along the beach and on level, clay polygon tundra nearby, where it was associated with *Potentilla pulchella*. The plants were prostrate and readily identified by the ciliate margins and hairy lower half of the lemmas.

This circumpolar species has a very dissected distribution in eastern Siberia and north-west North America. Tzvelev (1964) gives its eastern limit in Siberia as the New Siberian Islands and he specifically says it is absent from Wrangel Island and the Chukotsky Peninsula. Hultén (1968) shows it as occurring in the two latter areas, and in LANC there is an unnamed specimen distributed by LE and collected from Wrangel Island in 1967 by Petrovsky. With its small glumes and anthers, pilose lemmas and scabrous panicles it is clearly *P. angustata*. Previously the

westernmost locality in North America was thought to be Barter Island.

Colpodium vahlianum (Liebm.) Nevski

Prudhoe Bay: west side of the Sagavanirktok River estuary. 9 July 1975, no. A214/75, ALA, LANC. Only a few plants were found. They were growing in bare mud by a brackish inlet and were conspicuous by their bright green color, compared with the glaucous color of species of *Puccinellia*. The white, undulate roots were also characteristic.

According to Tzvelev (1964) this species has its eastern limit in Siberia on the Taymyr peninsula and material from Wrangel Island he refers to the new species *Puccinellia colpodoides* Tzvelev, known only from this island. Unfortunately, the Wrangel Island locality appears in Hultén (1968). *Puccinellia colpodoides* is usually easily recognized by its long anthers, 1.5–2.5 mm, compared with 0.8–1.3 mm in *C. vahlianum*. The difference in glume length (and consequently the ratio between glume and lemma length) which Tzvelev (1964) cites, is erroneous. For *P. colpodoides* he gives the lengths of the outer and inner glumes as 1.8 mm and 2.5 mm respectively, but two recent collections of this species in LANC and distributed by LE had glume lengths of 2.1–2.7 mm and 2.8–3.4 mm respectively. These ranges are indistinguishable from those of *C. vahlianum*.

Like *Pleuropogon sabinei*, *C. vahlianum* has previously not been reported west of Banks Island. But it has recently been discovered in Alaska in the Brooks Range (D. F. Murray 1975, personal communication).

Carex peckii Howe

Fairbanks: campus road by forest margin west of the University. 1 July 1975, no. A20/75, CAN, LANC. Livengood: north end of Brown Lake, 13 km south-west of Livengood. 3 July 1975, no. A49/75, ALA, C, E, LANC, S.

At the Livengood locality the sedge was growing in a grassy clearing by a track and near the lakeshore.

Hultén's (1968) map of this North American sedge shows a single locality in Alaska (Fairbanks) and one in Yukon (Dawson), but it has recently been reported by Scotter and Cody (1974) from the Mackenzie Mountains.

Minuartia biflora (L.) Schinz. & Thell.

Sourdough Creek: in snow-patch gully at head of creek, 980 m (3000'). 15 July 1975, no. A329/75, ALA, E, LANC. The plants were small and half hidden in a low bryophyte mat. The gully was only a metre or so wide and deep. It drained a small flush, colorful with *Primula tschuktschorum*, and, in addition to the *Minuartia*, harbored *Ranunculus eschscholtzii*, *Epilobium angallidifolium*, and *Antennaria monocephala* subsp. *monocephala*.

This new locality is the only one between those in the Alaska Range and in the Brooks Range.

Arenaria chamissonis Maguire

Sourdough Creek: exposed ridge north-east of the head of the creek and south of Hope Mountain, 1150 m (3500'). 16 July 1975, no. A357/75, ALA, LANC. Only a few cushions of this inconspicuous, *Cherleria*-like plant were found.

Arenaria chamissonis is almost restricted to Alaska, being previously known only from three areas — the western Brooks Range to the Bering Straits, the Seward and Chukotsky Peninsulas, and the Alaska Range.

Ranunculus eschscholtzii Schlecht.

Sourdough Creek: in snow-patch gully at head of creek, 980 m (3000'). 15 July 1975, no. A331/75, ALA, BM, E, LANC.

This locality represents an extension northwards across the Tanana River from its previous limit in the Mount McKinley area.

Potentilla rubricaulis Lehm.

Galbraith Lake: north side of valley north-east of Pump Station 4. 19 July 1975, no. A429/75, ALA, LANC. The site was a dry, sheltered, south-facing slope below a small limestone cliff. The rich flora included *Agropyron violaceum* subsp. *andinum*, *Bromus pumpeianus*, *Polemonium boreale*, *Myosotis alpestris*, and *Crepis nana*.

In the field, the few plants were clearly distinct from *P. pulchella*, seen shortly before at Prudhoe Bay, the leaflets being wider and softer. The material was submitted to K. Jakobsen, of Copenhagen University, who confirmed the identification, as also did Professor Hultén. Material from Galbraith Lake and east Greenland of this often misunderstood species and of *P. pulchella* from Prudhoe Bay and east Greenland are shown in Plate 1.

This is the first record of *P. rubricaulis* from Alaska. Like *Pleuropogon sabinei*, it was confidently included by Hultén (1968) in his Alaskan Flora although at that time it was not known west of the Mackenzie River, Northwest Territories.

Oxytropis deflexa (Pall.) DC. var. *sericea* Torr. & Gray

Fairbanks: roadside gravel opposite the airport entrance. 2 July 1975, no. A25/75, ALA, LANC, S. The material is typical of this variety. The illustrations of var. *sericea* and var. *foliolosa* (Hook.) Barneby in Hultén's (1968) Flora are reversed; the latter has not been recorded from central Alaska.

This find represents an extension of range north-westwards down the Tanana valley from Tanacross. *Douglasia gormanii* Constance

Livengood: east-west ridge north of the Elliott Highway, 55 km south-west of Livengood, 730 m

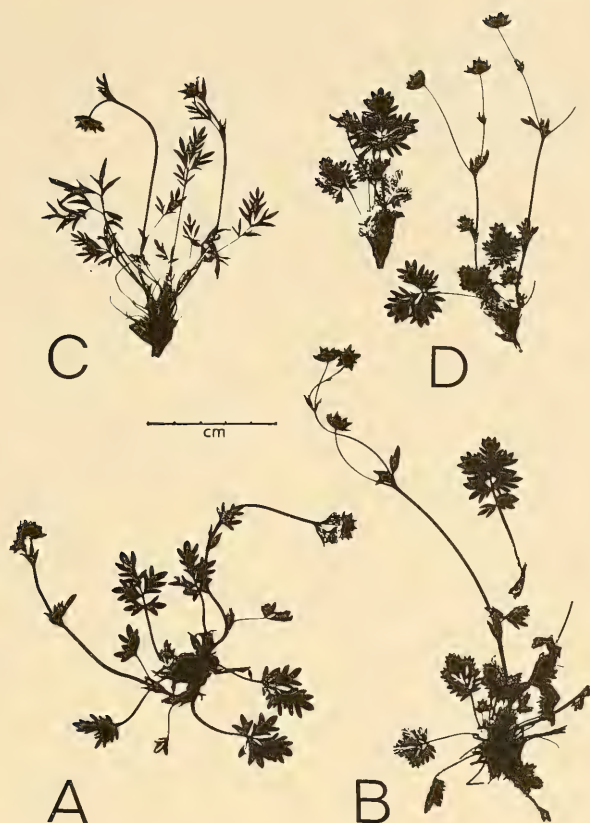


FIGURE 1. *Potentilla pulchella* R.Br.: A — Ørsted Dal, central east Greenland, G. Halliday, no. G68/74, 1974, C. LANC; C — Prudhoe Bay, Alaska, G. Halliday, no. A266/75, 1975, LANC. *Potentilla rubricaulis* Lehm.; B — Mestersvig, central east Greenland, G. Halliday, no. G20/74, 1974, C, LANC; D — Galbraith Lake, Alaska, G. Halliday, no. A429/75, 1975, ALA, LANC.

(2400'). 4 July 1975, no. A94/75, ALA, LANC. Only a few plants were found, well past flowering, growing in open, stony ground on the south side of the ridge and associated with *Draba fladnizensis* and *Ligusticum mutellinoides*.

The map in Hultén's (1968) Flora shows two areas for this rare Alaskan-Yukon endemic. The new locality effectively bridges the gap between them.

Euphrasia disjuncta Fern. & Wieg.

Sourdough Creek: track near junction of Sourdough and Polar Creeks, above the abandoned Placer Mine. 17 July 1975, no. A379/75, LANC. A few plants were found growing in the grassy center of the old overgrown track.

This locality, Gjaerevoll's (1967) record from

College, and a 1976 find by the English botanist E. C. Wallace (herb.E.C.W.) at Goldstream Crossing, 15 km west of Fairbanks, help to bridge the gap shown in Hultén (1968) between the Alaska Range and two isolated occurrences to the north, one on the Seward Peninsula, the other on the south side of the Brooks Range.

Pedicularis hirsuta L.

Prudhoe Bay: between the dock and the headland on the west side of the Sagavanirktok River. 11 July 1975, no. A216/75, ALA, LANC, S. Several plants were seen scattered along a terrace above the shore and occurring chiefly with *Eriophorum triste* and *Carex stans* in shallow depressions in an otherwise dry *Dryas* polygon vegetation.

This is the first record for this species in Alaska. Hultén (1958) regarded it as an amphi-Atlantic species with a distribution extending from near Coppermine, Northwest Territories (112°W) eastwards to the New Siberian Islands (140° E). The Alaskan locality (148° W) suggests that, like *Pleuropogon sabinei*, it is best regarded as circumpolar.

Antennaria monocephala DC. subsp. *monocephala* Sourdough Creek: in snow-patch gully at head of creek, 980 m (3000'). 15 July 1975, no. A322/75, LANC. The specimens were densely tufted and quite distinct from the stoloniferous subsp. *philonipha* (Pors.) Hult. which was found a few kilometres northwest of this site.

Although this is the first montane record north of the Tanana River, it extends up to the coast to Cape Lisburne.

In their provisional checklist of the vascular, bryophyte and lichen flora of Prudhoe Bay, Murray and Murray (1975) listed 150 species of vascular plants. This list can now be supplemented by the following 12 species (Herbarium specimens of all of these are in LANC.): *Phippsia algida* (Soland.) R. Br., *Pleuropogon sabinei* R.Br., *Puccinellia angustata* (R.Br.) Rand. & Redf., *Colpodium vahlium* (Liebm.) Nevski, *Ranunculus pallasii* Schlecht., *R. hyperboreus* Rottb., *Saxifraga rivularis* L., *S. foliolosa* R.Br., *Epilobium davuricum* Fisch. var. *arcticum* (Sam.) Polunin, *Polemonium acutifolium* Willd., *Pedicularis hirsuta* L., *Chrysanthemum bipinnatum* L. subsp. *bipinnatum*.

Acknowledgments

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Range Extensions of the Water Shrew and Mink Frog in the James Bay Region of Quebec

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Oxley, D.J., R.A. Coutts, and N.G.H. Boyle. 1977. Range extensions of the Water Shrew and Mink Frog in the James Bay region of Quebec. Canadian Field-Naturalist 91(3): 322-323.

Between 17 June and 28 August 1973 we observed Mink Frogs (*Rana septentrionalis*) and Water Shrews (*Sorex palustris*) in the vicinity of Kanaaupscow Post (54°05' N, 76°29' W).

Mink Frogs have been collected at Lac Aigneau (Logier and Toner 1961), Lac Nathalie (MacCulloch and Bider 1975) and further east in Ungava (Conant 1975). During our survey, three adult Mink Frogs were sighted, two of which were captured. The coloration of these specimens was variable; one frog

had an irregularly mottled pattern and the other had distinct spots. Although Wood Frogs (*Rana sylvatica*) and American Toads (*Bufo americanus*) were common, Mink Frogs were rare. The three sightings occurred only on small creeks; these had a mud and detritus bottom, stabilized by beaver dams, and the predominant vegetation was lilies, grasses, sedges, and dwarf willows. Our specimens, representing a range extension of 80 km in northwestern Quebec, have been catalogued at the National Museum of

Natural Sciences as NMNS 17492 and 17493; they were collected 31 July and 15 August 1973. Both were mature females with developing eggs and measured 70.5 and 65.0 mm after preservation. Their large size agrees with similar measurements found for other northern Mink Frog populations by Schueler (1975).

The two adult female Water Shrews were found on shore within 2 m of the Kanaaupscow River. One specimen was taken in a Museum Special trap in sedge-willow scrub. The other shrew was found dead on a sandy beach and large canid tracks around the body along with injuries on the specimen indicated that it had probably been killed and discarded by a wolf (*Canis lupus*). The previous known occurrences of the Water Shrew were recorded on the opposite side of James Bay at Cape Henrietta Maria and further north in Ungava at Fort Chimo (Peterson 1966). Our records represent an extension of over 300 km for the shrew in northwestern Quebec. The specimens have been catalogued at the Carleton University Museum of Zoology as CUMZ 4876 and 4877; total length measured 168 mm and 166 mm, tail vertebrae 80 mm and 80 mm, and weight 10.6 and 9.9 g.

We thank Francis R. Cook of the National Museum of Natural Sciences for confirming identifi-

cation of the Mink Frogs, and C. G. van Zyll de Jong of the National Museum for providing distributional data on the Water Shrew. We especially thank M. B. Fenton of Carleton University for his help in all aspects of the work. This study was supported by a grant from the Indian and Inuit Association of Northern Quebec.

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Range of the Bushy-tailed Wood Rat (*Neotoma cinerea*) in Alberta

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Soper (1961, p. 34) has stated that the Bushy-tailed Wood Rat (*Neotoma cinerea*) "is essentially a dweller in the Rocky Mountains, but stragglers infiltrate suitable Great Plains environment to a very limited extent." Elsewhere, Soper (1964, p. 199) noted an "unusual" record of this species from Ponoka, in central Alberta. Evidence presented here documents additional occurrences of the Bushy-tailed Wood Rat on the plains of Alberta.

A complete articulated skeleton (University of Alberta Museum of Zoology catalogue number 7769) of *N. cinerea drummondii* was discovered in September of 1973 along the Smoky River some 35 km east of Grande Prairie (NW 1/4, Sect. 16, Twp. 72, Rg. 2, W. 6). The unbleached state of the bone indicates a recent death and the articulated

condition makes transport by predator unlikely.

In July 1974 a nearly complete skeleton (UAMZ 7770) of *N. c. cinerea*, with skull and jaws intact, was recovered approximately 27 km south of Empress, Alberta at the Trans-Canada pipeline crossing of the South Saskatchewan River (NW 1/4, Sect. 18, Twp. 20, Rg. 1, W. 4). At the same time, the anterior part of a second skull (UAMZ 7771), with an associated left dentary, was found some 100 m south-east of the more complete find. These two specimens constitute a range extension of approximately 150 km north of previously known occurrences along the Milk River (Soper 1946; Rand 1948) and its tributaries (Nero 1956).

Another, although questionable, range extension is a record from the town of Strathmore, some 61 km

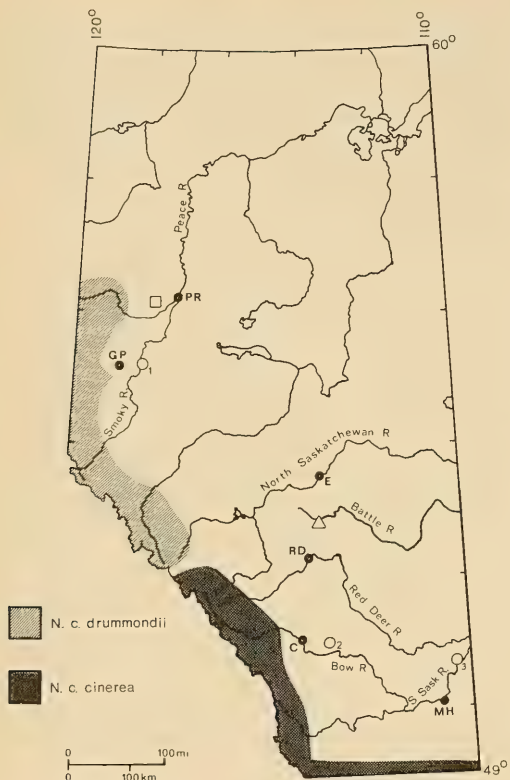


FIGURE 1. The range of the wood rat in Alberta. Hatching and cross-hatching indicate the well-established ranges of *Neotoma cinerea drummondii* and *N. c. cinerea*, respectively (after Soper 1964). Extralimital occurrences are depicted by the following symbols: □, Brownvale (Kelsall 1971); △, Ponoka (Soper 1964); O₁, Smoky River; O₂, Strathmore; O₃, Empress. Abbreviations designate major urban centers.

east of Calgary. This specimen was apparently collected by W. Sturm, a resident of Strathmore, in April 1970 and was subsequently donated to the Provincial Museum and Archives of Alberta, Edmonton (catalogue number Z72.102.26). More precise locality data are not available.

Previous extralimital extensions for the Bushy-tailed Wood Rat east of the Canadian Rocky

Mountains have been reported by Nero (1956) at Govenlock, Saskatchewan (in the extreme southwestern corner of the province), Soper (1964) at Ponoka, and Kelsall (1971) at Brownvale (near the town of Peace River, Alberta). The species appears to be established on the prairies in areas in, or adjacent to, major river valleys proximate to the Rockies. The records from Govenlock, Ponoka, Brownvale, Smoky River, Empress, and perhaps Strathmore document occurrences near the Milk, Battle, Peace, Smoky, South Saskatchewan, and Bow Rivers, respectively. The rocky exposures found along these rivers provide suitable habitat for the wood rat on the prairies. In those instances where the Bushy-tailed Wood Rat has been captured some distance from a river valley, it has been found inhabiting an occupied or abandoned human dwelling, a habit that is common for the wood rat (Rand 1948; Banfield 1974). It would be of considerable interest to establish the extent of the range of the wood rat on the prairie areas of Western Canada by a collection program along the major river valleys.

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News and Comment

Notice of Change to the By-laws of The Ottawa Field-Naturalists' Club

Changes to By-laws 12, 15, and 16 of The Ottawa Field-Naturalists' Club were passed unanimously by the Council at the meeting of 2 May 1977. These By-laws now read as follows:

12. *Disbursements of Club Monies*

Disbursements of Club monies shall be made by the Treasurer on receipt of properly rendered accounts verified by the Chairman of the Committee concerned or by a Business Manager or as specified by the Council. Disbursements of Club monies shall be made only by cheque bearing the signature of any one of the three following members of the Council: President, Treasurer, Business Manager of The Canadian Field-Naturalist.

15. *Annual Dues*

The schedule of annual dues shall be as follows:

Memberships —

Individual \$10.00

Family \$12.00

16. *Subscription Fees*

The schedule of subscription fees shall be as follows:

The Canadian Field-Naturalist —

Individual \$10.00

Libraries and Institutions \$20.00

Trail and Landscape —

Libraries and Institutions \$10.00

Diana R. Laubitz,
Recording Secretary

Wanted: Data on the Seasonal Distribution of North American Gulls

We are developing a procedure whereby the U.S. Air Force can predict the potential seasonal hazard to aircraft represented by gulls in parts of North America. This knowledge will be used to schedule missions around high-risk areas, thereby reducing the likelihood of bird/aircraft collisions. Supplemental data on local gull populations are needed from all parts of the continent. The assistance of field workers is solicited to aid us in this task. Please submit reports of your gull observations to Dr. William E. Southern, Department of Biological Sciences, Northern Illinois

University, DeKalb, Illinois 60115. Data will be gathered for a 2-year period beginning 1 September 1977.

For each observation, please provide the following information: list of species present, approximate number of each species, precise locality description, dates observed, any information about causes for concentrations (e.g., sanitary landfill operation), and any details about the frequency of such concentrations in the respective areas. Information is sought from inland as well as coastal localities.

Symposium on Wapiti

A symposium on the ecology and management of wapiti with particular reference to the Jackson Hole-Yellowstone ecosystem is planned for 3 to 5 April 1978. It will be hosted by the Department of Zoology and Physiology at the University of Wyoming. Papers are welcome on all aspects of the biology, ecology, and

management of wapiti (elk) and are not restricted to research projects conducted specifically in the Jackson-Yellowstone region. Titles and abstracts should be sent by 31 December 1977 to Dr. M. Boyce, Box 3166 Univ. Sta., Laramie, Wyoming 82071.

Book Review

ZOOLOGY

Biology of Insects

By David J. Horn. 1976. Saunders, Philadelphia.
vii + 439 pp. \$14.50.

This book was written to fill "a need for a basic text that regards insects as adaptive solutions to problems of survival in a heterogeneous and largely hostile environment." It seeks "to show how insects function and how selective pressures have shaped [their diversity]." The idea is very good; unfortunately its execution leaves much to be desired. Though Dr. Horn's warm and human introduction disposes one favorably to his efforts, and though he has dealt with a wide range of subjects and included a wealth of interesting information, his book suffers from several major faults as well as from a large number of imperfections of detail.

First, it is hard to imagine what class of readers the book is meant for. Though the author is a university teacher, the book is written at a conceptual level better suited to a high school. The language, too, is high-school English, subspecies *nearcticus*. On the other hand, what high-school course would accommodate a 400-page text on entomology? What student ready for an entomology course needs a grossly oversimplified account of the scientific method as an introduction? Who needs the elementary ideas of the biological species concept or of the origin of adaptation by natural selection explained, yet is ready for r- and K-strategies, for life tables, or for integrated control? Why give 120 pages to a non-diagnostic and hardly descriptive survey of insect orders and families?

Second, the text has not been well thought through. It is an inventory rather than a synthesis. Topics tend to be related by cross-reference rather than by integrated discussion. Difficult subjects are dismissed rather than dealt with. Numerical taxonomy is characterized in six lines, in which it is said to "have become a valuable addition to the systematic toolbox." Nutrition gets one page, indicating that insects need proteins, amino acids, carbohydrates, sterols, vitamins, mineral ions, and water. Terminology often is emphasized at the expense of concepts, and the emphasis given to terms seems rather erratic. For example, in the two pages on "Integument," the following terms are given in bold face: "chitin," "sclerotin," "apodemes," and "tentorium." A number of other equally important terms are given in ordinary type or omitted. The same lack of finish extends down

to paragraphs and sentences: parentheses are often used to bolster a passage that should have been rewritten, e.g., "Most spiders feed on insects (and other spiders) though some of the largest tropical species can (and do) eat small fish and birds."

A third major defect is the poor quality of the illustrations. Most of the drawings are crude, many are inaccurate or unrecognizable, such as the clothes moth in Figure 3-55 and the gelechiid in Figure 3-57. The caterpillars shown in the illustration of holometabolous development in Figure 2-13 have prolegs on every abdominal segment except usually the anal, and appear to add abdominal segments as they grow. The three supposed *Colias* species in Figure 4-26 bear no resemblance to any *Colias* I have ever seen, but might be inaccurate renditions of cabbage butterflies. A large proportion of the photographic illustrations are also unsatisfactory, being out of focus, low in contrast, based on damaged material, or otherwise substandard.

On a more detailed level the errors and inconsistencies are too numerous for individual mention. The International Commission on Zoological Nomenclature makes, interprets, and at times suspends rules, but does not police them as stated on p. 13. Ordinal, family, and other higher-group names are sometimes used as singular nouns, sometimes as plural. They should be plural. *Antheraea* is consistently misspelled *Anthraea*. The armyworm is *Pseudaletia unipuncta*, not *unipunctata*, as given on p. 119. On the same page and elsewhere the plural abbreviation "spp." is used in place of the singular "sp." Figure 3-60 A, labelled "Indian meal moth, family Pyralidae," is a microlepidopteran, not an Indian meal moth or a pyralid.

I think it only fair to say that in reading *Biology of Insects* I learned many things about insects and their biology that I was unaware of before. The bibliography is extensive and includes a good selection of useful titles. Here, too, however, caution is needed. Holland's *Moth Book* was first published in 1903, not 1913. The reference to Dominick et al., *The Moths of America North of Mexico*, contains five separate errors of citation.

I regret that for most readers *Biology of Insects* cannot be recommended.

EUGENE MUNROE

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North American Game Birds of Upland and Shoreline

By Paul A. Johnsgard. 1975. University of Nebraska Press, Lincoln. 183 pp. \$6.95.

North American Game Birds of Upland and Shoreline "is intended as a guide to the more common species of American game birds." Johnsgard "decided to include all of the native and successfully introduced species of gallinaceous game birds of North America occurring north of Mexico as well as the migratory game birds other than waterfowl that are legally harvested in significant numbers in the United States and Canada." A total of 29 species, organized by order, are listed in the book.

The treatment given each species is standardized. For each species there are sections on distributional range, identification, field marks, age and sex criteria, habitat and foods, social behavior, and reproductive biology. Line drawings, black-and-white and color photographs are also included within the book, although not all species are equally treated.

Within the section on reproductive biology the material contained includes information on egg-laying, clutch size, incubation period, parental care and protection, and time to flight. The section on social behavior outlines the species' territoriality and flocking behavior. The age and sex criteria section contains information on how to distinguish between males and females of the species as well as how to identify immature birds from adults. Under field

marks, Johnsgard points out some of the seasonal variations that occur within the species as well as the features that distinguish one species from another similar-looking species. Generally speaking the book is very well organized and contains a great deal of material in capsulized form.

Johnsgard includes in his book a very interesting section entitled 'The Hunting and Recreational Value of Upland Game Birds.' Within this section he points out that approximately a billion dollars annually is spent in pursuit of small game. Furthermore "the average hunter of upland game birds might be expected to kill in the course of a season about 7 birds." No matter how important hunting appears to be, "it is clear that the proportion of Americans who elect to enjoy wildlife through non-consumptive methods may be at least as great as or possibly greater than those who prefer to carry a gun when afield."

Johnsgard's book is highly recommended to all persons wishing to know a little more about game birds. As the author himself states "the book is intended to be fuller than the typical bare-bones field guides but less detailed than a full scale monographic treatment."

PETER CROSKERY

Ontario Ministry of Natural Resources, Ignace, Ontario

Waterfowl Studies

By Bruce Burk. 1976. Winchester Press, New York. (Canadian distributor Nelson, Foster and Scott, Willowdale). 254 pp., illus. \$17.95.

"The availability of good wildlife photographs has played by far the most important role in the development of wildlife art." With this thought in mind, *Waterfowl Studies* by Bruce Burk was intended to assist the wildlife artist. The book provides a reference collection of waterfowl photographs "for the decoy maker and collector, hunter, bird watcher, waterfowl artist and naturalist." "The text of this book has been kept to a minimum to provide maximum space for photographs."

Burk's collection of North American waterfowl photographs include 21 ducks, 8 geese, and 2 swans. Each species is photographed from a variety of angles so as to record the characteristic shapes and features of the species profiled. "For the first time in one volume, body form, position and plumage detail are accurately recorded."

Waterfowl Studies does not include the various

marine ducks of North America, it concentrates on the inland species. For some reason Burk has included only one of the three common merganser species, the Hooded Merganser. Omitted are the American Merganser and the Red-breasted Merganser.

About 90% of the included photographs are in black and white. Some of these black-and-white photographs are grainy, probably the result of the film type and speed preferred by the author. Nearly all included photographs are close-up pictures of the birds profiled.

As Burk states "although this collection of waterfowl photos has been assembled primarily to aid the artist in making realistic bird carvings and paintings, these pictures will also be of interest to other bird lovers and naturalists." One could not really consider this book as informative; however I found it very enjoyable.

PETER CROSKERY

Ontario Ministry of Natural Resources, Ignace, Ontario

An American Crusade for Wildlife

By J. B. Trefethen. 1975. Wincester Press and Boone and Crockett Club Book, New York. 383 pp. \$14.50.

An American Crusade For Wildlife is a historical review of wildlife conservation in America. The period covered by the review is from the arrival of the first Europeans in North America until the present day. Within the text, Trefethen reports the factual history of wildlife conservation, but more importantly he reveals the changes in wildlife conservation philosophy that have evolved in North America.

In the days of the early settlers the wildlife resources of North America were never considered as a limited resource. They were simply there and were to be utilized at the imagination of the user. Under such an attitude evolved the buffalo hunter, the mountain man, and the market hunter. Primarily as a result of the activities of these commercial resource consumers, the limits to wildlife resources became apparent. Buffalo numbers dwindled, furbearers such as beaver declined, and deer vanished from parts of North America. The North American society of the day saw the end nearing for species previously abundant.

Another interesting aspect of wildlife conservation, as pointed out (indirectly) by Trefethen, is that where change was necessary, the proposal for change generally originated from outside the political realm. Most of the early legislation regarding wildlife conservation was proposed, lobbied for, and supported by, public conservation action groups. *An American Crusade for Wildlife* reviews the origin and original purposes for some of the groups we know today.

Wildlife resources have seldom been a subject of political party platforms. *An American Crusade for Wildlife* suggests that through history individual politicians, regardless of party, have proposed or supported wildlife conservation efforts. It would appear that even among politicians, wildlife conservation is a very personal subject.

The pressures upon wildlife resources have resulted primarily from human population increases. "The heaviest impact of the white settlement came not so much from direct killing that attended it as from the wrenching changes in the prevailing habitat brought about by the intrusion of European farming."

No book on the wildlife conservation movement would be complete without comments on today's issues and problems. If *An American Crusade for Wildlife* has a weak point, then this would be it.

Trefethen's list of topics of concern of today's wildlife conservationists is rather short and incomplete. It includes endangered species, seal hunting, and oil spills. It does not include environmental education, resource management of private land, or user group conflicts.

An American Crusade for Wildlife is very much United States oriented; even so, it makes fascinating reading. One should remember that many events in United States conservation history have had direct parallels in Canada.

PETER CROSKERY

Ontario Ministry of Natural Resources, Ignace, Ontario

America's Master of Bee Culture. The Life of L. L. Langstroth

By Florence Nail. 1976. Cornell University Press, Ithaca N.Y. 215 pp. \$9.95.

There are few industries which can pinpoint the day when the major discovery was made affecting their future development. Florence Nail, in her book, "The Life of L. L. Langstroth," has done just that. By careful research of all of the writings of Langstroth and his personal notes, Florence Nail has been able to pinpoint this as October 30th, 1851, and she has even been able to reproduce his drawings of that date. Langstroth's discovery was based on the fact that the bees use space of approximately $3/8$ inch through which to pass and they will not fill this space either with bee glue (propolis) or wax. Langstroth stated on the day of his discovery, "The use of these frames will, I am persuaded, give a new impetus to the easy and

profitable management of bees." Little did he realize how true these words were. Florence Nail, in a very interesting manner, has portrayed not only all of the factors leading up to this discovery but the trials and tribulations through which Langstroth went during his lifetime's work; he was a minister of the Christian gospel, the inventor of the first practical moveable frame beehive, and author of a book, "*The Hive and the Honeybee*," which will forever remain a classic in bee culture. "*The Hive and the Honeybee*," now published in an absolutely different form and recently extensively revised in 1975, is a fitting tribute to the original author and is still recognized as the beekeepers' leading manual.

Florence Nail's account of Langstroth's life and work is more than a biography of L. L. Langstroth; it

portrays the struggle to improve the beehive and the fact that even though Langstroth realized the importance of his discovery, many of those who made use of it, did not until much later in time. Florence Nail was influenced, to a great extent, in her preparation of the manuscript, by Dr. E. F. Phillips, who must have been a great inspiration to her as, at that time, he was one of the leaders of the industry. Those who knew Dr. Phillips would be interested in the introduction which he wrote and which portrays rather clearly the controversies of even that period, of the late '30s and early '40s, which were going on

between Phillips and other leaders of the industry. He mentions fads such as top entrances in winter preparation, a practice which has now become quite common in areas where wintering is difficult.

This fascinating book, by Florence Nail, is a must for all interested in apiculture, whether they be scientists, hobbyists, or commercial producers.

G. F. TOWNSEND

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Biology of the Kaminuriak Population of Barren-ground Caribou. Part 4: Growth, Reproduction and Energy Reserves

By T. C. Dauphiné, Jr. 1976. Canadian Wildlife Service, Ottawa. Report Series 32. 71 pp. \$3.25.

This is the fourth and final report dealing with the intensive study of the Kaminuriak caribou population conducted by biologists of the Canadian Wildlife Service in cooperation with the governments of the Northwest Territories, Manitoba, and Saskatchewan, between 1966 and 1968. Earlier parts by G. R. Parker (1974), F. L. Miller (1974), and D. R. Miller (1976) were published in the same report series. The present study relies on conclusions reached in the previous parts with reference to population, age, and diet, to analyze the anatomical data obtained from post mortem examinations. In some respects it is the most important of the parts, in that conclusions were drawn on various environmental factors that are controlling the population size. Basic management procedures are recommended to maintain the population as well.

A number of vital statistics dealing with growth, reproduction, and survival of this population have been determined. In comparison with other mainland populations, the Kaminuriak caribou showed slow growth, modest size, and delayed puberty, which is thought to be a reflection on their environment.

Perhaps the most interesting findings were related to the annual nutritional and reproductive cycles.

Increases in body size and weight were restricted to a summer growth period from June to October. Mature caribou were heaviest in autumn immediately prior to the rut. Adult males lost about 30 percent of their maximum weight during the rut, but managed to maintain that weight until the next growth cycle began in spring. Adult females lost 11 percent of their mean autumn weight by late winter and did not begin to regain weight until mid-July.

This annual cycle of weight change was confirmed in the size of fat deposits. Both sexes had maximum fat reserves in September. The mature males mobil-

ized these reserves during the rut when the back and visceral deposits were rapidly depleted. Pregnant females maintained high fat reserves in the autumn, but experienced a steady decline of reserves during the winter and spring, to reach their nadir in June and early July at the time of parturition and lactation. A higher percentage of females than males mobilized marrow fat reserves.

Over half the 1½-year-old females ovulated but only 2 percent conceived; 48 percent conceived at the age of 2½ years and 90 percent conceived at 3½ years and older. Ovarian scars indicated that an average cow bore a calf four out of every five years. Thin cows generally speaking did not conceive. The observations suggest a cycle of gradual exhaustion of body condition during successive pregnancies, followed by a barren year accompanied by physical recuperation and then renewed breeding activity. Calf production was generally high, but depth of winter snow seemed to be an important factor in calf survival to the yearling class.

The findings of this study indicate the key importance of summer range to the survival of Kaminuriak caribou. This was especially true of the females which reached their nadir of stored fat at the time they were nursing their calves. The amount of fat they can amass by autumn appears to influence their chances to conceive and the survival of calves.

Indicated management strategies included the harvesting of a greater percentage of males, and possibly wolf control. It was also recommended that human disturbance of caribou on the summer range should be carefully regulated.

A. W. F. BANFIELD

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Répartition géographique des poissons, leur abondance relative et bathymétrie de la région du Lac Saint-Pierre

By Gérard Massé et Jean-René Mongeau. 1974. Service de l'Aménagement de la Faune, Ministère du Tourisme, de la Chasse et de la Pêche, Québec. 59 pp., illus.

Cartes de répartition géographique des espèces de poissons au sud du Québec, d'après les inventaires ichthyologiques effectués de 1963 à 1972

By Jean-René Mongeau, Albert Courtemanche, Gérard Massé, et Bernard Vicent. 1974. Faune du Québec, Rapport Spécial (4): 1-92.

Les poissons de la région de Montréal, la pêche sportive et commerciale, les ensemencements, les frayères, la contamination par le mercure et les PCB

By Jean-René Mongeau et Gérard Massé. 1976. Service de l'Aménagement de la Faune, Ministère du Tourisme, de la Chasse et de la Pêche, Québec. 286 pp., illus.

Gaps in occurrence on species distribution maps frequently result from lack of collecting rather than absence of the species. Museums and environmental agencies frequently lack the funding or planning that would result in thorough zoological and botanical surveys that would produce excellent spot distribution maps. It is desirable that such maps be based on voucher specimens whose identity can be verified when called in doubt or when taxonomic changes are made.

High-quality distribution maps serve a number of useful purposes including the following:

- (1) recreational use — where to go to bird-watch or fish,
- (2) resource use — where to go to catch fish,
- (3) resource management,
- (4) determination of effects of environmental disturbance or pollution,
- (5) zoogeographic studies,
- (6) ecological studies.

Since 1963 the Ministère du Tourisme, de la Chasse et de la Pêche has been surveying the fish fauna of southern Quebec. Samples have been made every 1/5 mile along water courses. Such methodical sampling with a variety of gear permits the drafting of distribution maps which indeed show where a species is present and where it is absent.

The appearance of the results has begun in the above publications. One species is presented per map with the stations positive for the species indicated by a dark spot. Some maps even indicate whether the species was rare (<50), abundant (50-200), and very abundant (>200).

The ministry and its team of workers is to be commended for the production of these fine maps which will be useful to many groups. It is hoped that other organizations and museums will be given the resources to produce similar atlases for our fauna and flora.

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Méthodes de pêche expérimentale, en eau douce, à l'usage du biologiste et du technicien de la faune

By Jean-René Mongeau. 1976. Rapport Technique, Service de l'Aménagement de la Faune, Ministère du Tourisme, de la Chasse et de la Pêche. 83 pp.

Biologists and technicians trained in universities receive too little training in the use and care of fishing gear, even though it is very important in sampling populations and in the collection of specimens. Under one cover Mongeau has brought together information on techniques of fishing with gill nets (including setting them under ice), seines, traps, trap nets, dip

nets, set lines, electric shockers, and rotenone. Detailed specifications are given for gill nets and seines and instructions on care are offered. The text and photos together offer an excellent introduction to the techniques of fishing.

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The Anatomy of Fishes. Parts I and II.

By Wilhelm Harder. 1975. E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart. Part I, 612 pp. Part II, 132 pp., 337 figures, 13 plates. \$96.40 (U.S.).

Since Harmer's (1904) *The Cambridge natural history* and Goodrich's (1909) *Cyclostomes and fishes*, there has not been an in-depth treatment of the anatomy of fishes in the English language. There is a need, because fishes are an ancient group, rich in taxa which are more highly diversified in anatomical structure than other more recent vertebrate classes. Harder's *Anatomy of fishes*, a translation and revision of an earlier German text, admirably fills the lacuna.

My first impression, one never dislodged, was that here was a source book, solidly packed with information. Closer inspection suggested that even the machete of today's journal editor must go rusty whilst seeking verbiage to slash.

A fair amount of text is devoted to basic zoology (definition of positional terms such as caudad, discussion of protoplasm and cells) or science (resolving power of light microscopes). This means that the text could be used without difficulty by beginning university students. But the text then proceeds to deeper levels, and more detail at the cellular and tissue level is given than in the usual ichthyology text. Anatomical terms are in italics, making it easy to skim through paragraphs for terminology. The scientific names of fishes are in ordinary type face. A stream of functional thought runs through the chapters; it is not just a descriptive anatomy. The references are grouped, to the reviewer's mind inconveniently, by chapter at the end of the book. This means that first the chapter group must be sought before finding the references.

The reviewer finds the level of scientific accuracy high and the breadth coverage very good, although the author modestly admits the impossibility of complete coverage. A few lapsi may be indicated. It is stated that the radii branchiostegi develop phylogenetically out of the lateral gularia (it is, rather, the reverse), also, that in general there is only one dorsal

fin-bearing element per muscle-segment (usually, in fact, there is more than one, the prime exception being the blennioids). D. Rosen's work on cephalic muscles in fishes was not cited. According to V. M. Makushok, contrary to Harder, trunk lateral lines are present in almost all fishes reported to be lacking them, including clupeids; it is only the canal and pores that are missing.

Two works worthy of mention published too late for Harder to include are these: R. Winterbottom (1974), *A descriptive synonymy of the striated muscles of the Teleostei* (Proceedings of the Academy of Natural Sciences Philadelphia 125(12): 225-317); and J. S. Nelson (1976), *Fishes of the world* (John Wiley and Sons, New York, London, Sydney, Toronto. 416 pp.). The latter would have provided an excellent basis for classification.

The translator has generally done a good job grammatically. He has done less well with the terminology (fin-sails instead of fin lobes, under-water-floor instead of bottom, bristle-teeth instead of cardiform teeth, keel bone in preference to parasphenoid, but such lapsi are not common). For the most part these will be passed over without problem by the reader. The editing has not been of high quality. Pages 4 to 6, for example, contained seven misspellings, grammatical infelicities or taxonomic errors. Throughout the volume one finds similar errors (Vladikov for Vladkyov, Colette for Collette, diverticle instead of diverticulum). The greatest carelessness is found in regard to the bibliography. In looking up references in five pages of text, seven are found to be missing, two had disagreements in dates between the text citations and the bibliography. Such carelessness is not acceptable.

Despite its editorial shortcomings Harder's *Anatomy of fishes* is an excellent reference book.

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Wolf... Kill! The Wilderness Called Shunka

By Marika Lumi. 1976. Van Nostrand Reinhold, Toronto. 195 pp., illus. \$9.95.

The title *Wolf... Kill!* was presumably chosen to ensure this book sells well. It is somewhat ambiguous, however, because the hero, tundra wolf Shunka, is anything but a killer. No doubt the title is meant to refer to many people's attitude toward the wolf: it should be shot on sight. The whole point of the book is

that wolves can be brought up to live amicably with people, in this case often sharing their house, their food, and their leisure time. Marika Lumi and her husband wanted to prejudice people in favor of wolves, which they have been able to do with their films, this book, and by means of Shunka himself.

Neither is the subtitle about wilderness entirely suitable, for although Shunka is supposed to typify

for us the wilderness, he was in fact bought as a cub from the Alberta Game Farm near Edmonton. The author and her husband then raised him for a year first in Toronto, and then in the country near Pickering. When they could no longer manage him they sent him to a Natural Science School near Ottawa where he thrilled hundreds of school children who were allowed to visit with him in his pen. Eventually he was sent to British Columbia where the people were less understanding about wolves and where he was finally shot after he had escaped.

The author and her husband became devoted to Shunka, Marika Lumi describing him so affectionately that we come to admire him too. Although in general Shunka was treated as far as possible as a dog, and was given a dog as a constant companion, he never acted entirely like one. He loved to romp and play with human beings and to join with howls in their

sing songs, but his owners were never able to housebreak him, nor to teach him not to chew up books, shoes, or anything else he could fit into his mouth. Shunka considered his owners not as dogs would, but as members of his pack. He was dominant to the dog Happy and to the author, but submissive to the family cat and to the man of the house who controlled his life, feeding him, handling him on the leash, taking burrs from his coat, and driving him to the vet. This book about Shunka gives us a good idea of the nature of a wolf and will, I hope, create an improved climate of opinion for this fascinating species.

ANNE INNIS DAGG

Box 747, Waterloo, Ontario N2J 4C2

A Field Guide to Birds' Nests

By H. H. Harrison. 1975. Houghton Mifflin Company, Boston. 257 pp., illus. \$10.75.

This book was written as an accompaniment to "Field Guide to the Birds" by R. T. Peterson (1934. Houghton Mifflin Company, Boston) to enable identification of the nest of a particular species without seeing the adult birds. It describes common nesting sites, nest construction, and characteristics of the eggs of all species of birds in the United States east of the Mississippi River. The author notes that usefulness of the book diminishes in the Canadian boreal forest. The format includes a color photograph of the nest and eggs of most species, followed by sections describing breeding range, habitat, nest, and eggs. A further section entitled "Notes" presents facts or personal experiences of the author for each species. Excellent black-and-white sketches of most birds by Ned Smith are also included.

Detail provided by the author's photography is exceptional. Combined with the written description, a vivid portrayal of nest and eggs is attained. For example, the user can readily identify the nests of most species of sparrows through egg characteristics. Other species are much more difficult. Some nests, particularly those of the cavity nesters, were disturbed for photographing. In several cases, for example, Long-billed Marsh Wren, the photograph would have been more meaningful if the nest had not been opened. In others man-made nesting sites were used, detracting from the value of the picture.

Minor errors or incomplete explanations are found in certain of the text. The Spotted Sandpiper is described in a misleading fashion as inhabiting open

prairies, dry fields, and pastures. Contrary to the statement in the preface, not all ducks commonly lay in one another's nests. Species that are characteristically parasitic should have been noted. The discussion of evolution of nests is somewhat teleological although this problem is difficult to avoid, particularly in a book of this nature. The Redhead is the only species incorrectly omitted, although the author notes others which might have been included. Items that may have enhanced this book include a description of nesting period (done for some birds but not all), and a section similar to that found in "Field Guide to the Birds" listing like nests and eggs of other species and any differences. Ability to use this book would be improved considerably through development of a key based on habitat and location of the nest. As it is, the user requires a good knowledge of bird species to locate readily the correct photograph. Also, a statement of the dangers of disturbing birds during the laying period, numerous successive visits, and handling of fragile passerine eggs would have been of value. On the whole, however, the text itself is informative, useful, and apparently free of editorial errors.

Accomplished bird-watchers and beginners will find this book useful in some situations where the nest and eggs are particularly diagnostic of the species. But, with few exceptions, the only way to be absolutely certain in identification of a nest remains in seeing the adult.

IAN D. THOMPSON

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Pictorial Guide to the Mammals of North America

By Leonard Lee Rue III. 1967. Apollo Editions, Crowell, New York. 299 pp., illus. \$9.95.

This attractive book is more than a pictorial guide; it has two or three pages of text devoted to each of the 66 species discussed, so that besides being interesting to read, it should be useful as a reference source for laymen. It is written in the easy style made popular in the author's series *The World of the Beaver*, *The World of the Red Fox*, *The World of the Raccoon*, etc.

Rue's choice of mammals for this book is practical. He concentrates on large common species, including small mammals to round out the collection. If one is limited to one shrew, the short-tailed shrew *Blarina brevicauda* is the best-known example; if there are to be only two bats, the little brown (as a hibernating species) and the red (as a migrating one) are suitable representatives. It is odd, however, to have all marine mammals represented by Californian sea lions. Of the mammals discussed, only 13 are not found in Canada.

The many illustrations in this book will make it especially appealing to children. The photographs, most of them excellent, are all by the author, who has obviously traveled widely in North America. The small maps of North America suffer the problems of

all greatly reduced maps — the extent of the distribution of some species is underdone, and of others seemingly overdone. The badger and the cottontail are missing from Ontario, while the wolverine is represented in eastern Canada by a wide sweep of gray that belies its almost endangered status. The footprints are detailed but their arrangement into tracks is disappointing. Unless the gait an animal used to make the track is noted, it is usually impossible to tell which feet are which. For the black bear the forefeet are obviously different than the hind feet, but there is no legend indicating which is which, or how big either is.

The appendices include a brief mention of what mammals may be seen in the many federal, state, and provincial parks on this continent; a compilation with addresses of the bureaus, departments, and agencies that deal with wildlife; and a list by family of all the mammals present in North America together with their scientific names. The reference list is short with the most recent item 1964, underlining that this printing of the 1967 edition has not been updated.

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BOTANY

Plant Names

By T. S. Lindsay. 1976. Facsimile of 1923 edition. Gale Research Co., Boston, Massachusetts. vii + 93 pp. \$8.

This small book, designed for gardeners and naturalists, deals with two topics: the principles of botanical nomenclature, and the origins and meanings of plant names.

The International Code of Botanical Nomenclature did not exist when this book was first published. Some parts of Lindsay's discussion of the rules of nomenclature, based on the Vienna Rules of 1905, still apply, but other parts are no longer correct, e.g., "There is no accepted law as to names of varieties (i.e., cultivars). But botanists heed them not." In 1923, the Primulales could correctly be designated by the now-obsolete term "cohort," but even then the Primulaceae should not have been called a "division," nor was the recognition of botanical varieties considered to violate the principle of binary nomenclature. Those

seeking an introduction to botanical nomenclature must look to more authoritatively written and more modern works.

The names of plant genera, whether Latin or English, for which derivations are given are few, and appear to have been selected almost at random. Indexed under G, for example, there are only 21 Latin and 9 English names. Derivations of 10 of the Latin and 6 of the English names are scattered through the text; the others are merely classified as "commemorative" or according to their linguistic origins. The chances are, therefore, that a generic or common name which one might wish to look up will not be included. Fortunately, several books that provide more extensive lists of meanings and derivations for botanical and common names are now available. Even a dictionary is a superior reference for this purpose.

The definitions of specific epithets are more numerous, although in this area, too, this book falls far short of more recent works. There are, moreover, many inaccurate or vague definitions, e.g., "*oxy-canthus* (sic), with sharp flowers"; "*racemosus*, full of clusters"; "*repens*, sudden, unexpected." There are no illustrations.

If no better works were available in 1923, this book

may then have been a useful addition to the popular literature of botany, but I see no reason to acquire it today.

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Wildflowers across the Prairies

By F. R. Vance, J. R. Jowsey, and J. S. McLean. 1977. Western Producer Prairie Books, Saskatoon. 214 pp., illus. Cloth \$14.95; paper \$8.95.

In the words of the second author, "This book on wildflowers is, in general, a book to 'open the eyes' of people of all ages as they look at the flowers of this region of North America. It is for travellers who come here from far lands, and for those who have lived on the prairies. It is a book for farmers and summer cottage residents, for those who visit our parks, and for those who walk or drive in cities and along the roads of Saskatchewan and neighboring areas. It is a book for all students of the natural world." There is no doubt that the over 400 excellent color photographs will help serve this purpose in the prairies of Saskatchewan, Alberta, Manitoba, Montana, the Dakotas, and to a lesser extent beyond these limits.

An informative text describes the plants and gives interesting notes on the habitats and areas where 186 species are found in Saskatchewan. Line drawings of flowers, seeds, or fruit accompany many of the species treated. These are of mixed quality, and indeed some might best have been omitted. Color photographs of related species are found throughout. These, although as good as those of the species being discussed, were

found to be confusing by their presence on the page, even though they were mentioned in the text, and it seemed that they had been introduced because there was a picture available. It would have been better if these pictures had been given a page of their own, with their own descriptive text.

Included in the volume are five pages of line drawings depicting various types of leaves, inflorescences, and flowers, which were reproduced from *Wild Plants of the Canadian Prairies* by A.C. Budd and K.F. Best. This is a most useful inclusion. Also to be found are a map depicting the area covered, a glossary, a short bibliography, an index to common and scientific names of species and families, and a color index which classifies the plants into four main flower color groups: red-pink, purple-blue, white, and greenish-yellow-cream.

Fenton R. Vance took most of the photographs, but photo credits are given to some 30 additional individuals. The line drawings were executed by J. S. McLean, and the text written by J. R. Jowsey.

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Spring Flora of Wisconsin

By Norman C. Fassett. 1976. 4th ed. (revised). University of Wisconsin Press, Madison. 413 pp., illus. Paper \$3.95; cloth \$8.50.

Previous editions of this little book which treats plants growing without cultivation and flowering before June 15th in Wisconsin, have proven to be immensely popular. This fourth edition is a greatly enlarged and revised version which has been prepared by Olive S. Thomson. In it, new species that represent recent introductions to the state have been added, descriptions have been enlarged, habitat and distribution data have been revised, over 100 new illustra-

tions have been added, and some illustrations from previous editions have been redrawn.

This most useful book will be welcomed in class and in the field by students not only in Wisconsin, but in the adjacent states and nearby parts of Canada. Naturalists in this region will also find this pocket-sized book a useful addition to their libraries even if they already possess an earlier edition.

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Canadian Forestry. The View beyond the Trees

By C. R. Stanton. 1976. MacMillan, Toronto. 70 pp., illus. \$5.95.

The vital role of forests as national wealth is explained. Their management is of prime importance to derive benefits perennially. A historical background is sketched beginning with the construction of houses in the past by Indian tribes. After the European settlements appeared, the shipbuilding industry grew up, utilizing timber. Later on lumber mills were established. Finally paper industry assumed major importance in national economy.

A beautiful colored map of Canada is provided with forest regions and principal tree species, clearly marked. Typical pictures of each kind of vegetation were separately presented to give an idea how each region of vegetation looks like, e.g., boreal, montane, deciduous, and subalpine forest. Bargrams show the forest land in hectares and merchantable timber in cubic metres in each province of Canada. A short account appears on forest administration policy. As fire and pests cause maximum damage, management methods and intensive protection methods are required. New techniques of planting are being developed from time to time in order to keep pace with harvesting. Forest inventory work is speeded by

digitized stereoscope, which presents forest measurements from large-scale aerial photographs in computer-ready form. Mechanized logging operations are carried out replacing the traditional lumberjack with his axe and saw. Veneers, plywoods, particle boards, pulp and paper, secondary wood, shingles, and maple syrup are some of the products of forests. At the same time, wildlife preservation is an adjunct function. Various research centres have been set up to tackle different problems.

This book has numerous colored photographs of very high quality. It is not too technical; A layman could easily understand what forests are, how important they are for man's survival, and their vital role in national economy. Any student (Grade 6 on) could get a bird's-eye view of Canadian forests. I recommend that everyone take a glance at this title irrespective of their background, whether in biology, ecology, or forestry or whatever. We must congratulate C.R. Stanton for bringing out this concise edition.

DR. C. R. CHEVENDRA

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ENVIRONMENT

"Man of the Woods"

By Herbert F. Keith. 1976. Syracuse University Press. Syracuse, New York. 164 pp. \$5.95 (paperback edition of a 1972 publication)

"*Man of the Woods*" is a tale of what most people aspire to do with their lives, to be whom and do what they desire. Herbert Keith dreamed of being, and was, an Adirondack guide on the Oswegatchie River. His work is autobiographical of his life in and love for the town of Wanakena and the Oswegatchie River.

His love for the region was kindled through his boyhood vacations to the lumber town of Wanakena, New York at its peak at the turn of this century. The early chapters of his work give an interesting account of Wanakena's beginning and decline, which depended upon the production of the timber industry. It was this industry that first opened the region for tourism and guiding through the creation of railroad spurs to haul logs to the mills. It was during the timber and post-timber era that Keith dwells longest and introduces the reader to some of the more colorful

characters and events of the time.

His story-telling is based primarily on humor. There are moments of personal tragedy, however: the loss of a friend, the in-roads of an insatiable recreative society, and the loss of one man's harmony with nature, which gives the reader a balanced view of the nature of wilderness living, a respect for all things great and small.

The third period Keith dwells upon is that of the automobile. Keith dwelt longest on the first two periods perhaps because they were most memorable to him. Perhaps too, the age of the automobile gives him pain to have seen the careless casual destruction caused by overeager, overbearing, and undertrained modern man. Keith hones in on the problems associated with this new "sport" person in Chapters 18 and 19. I feel he tends to editorialize in these chapters and breaks out of his role as a story-teller, which disrupts the mood set throughout the rest of the work. Maybe this is Keith's method to cause a self-

evaluation of the reader's attitude toward nature.

Apart from Keith's skills as a story-teller, the work contains a fine pictorial essay of the characters and way of life which compliments the story line at the moment. Another strong feature is the notes accompanying the work, referred to at the back of the text; these broaden its usefulness as a source of social and historical information. Also included are two maps. The first is of the railroad system on page 5, but it lacks a directional bearing and scale, which may

limit its value. The second map on page 95 is a regional map which lacks a scale.

Keith's "*Man in the Woods*" is a work well done and a fine piece of reading. It has something of interest for all. I highly recommend it.

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Ecological Diversity

By E. C. Pielou. 1975. Wiley, New York. 165 pp. \$14.95.

This book is primarily intended for studies of ecological communities. The questions confronted by an ecologist are (1) How many trophic levels are present, and are there a small number of intricately anastomosing food webs or a large number of simple unbranched food chains? (2) Do the species differ much in the amplitude of their tolerance ranges for various environmental variables? (3) Which of the species are autochthonous (evolved locally) and which allochthonous (evolved elsewhere) and which (if any) will soon become locally or globally extinct? (4) Are most or all of the community's species fully adopted to the habit they occupy and to one another?

The principles, explanations, applications, and derivations outlined in this book would throw some light on community studies. Moreover, the author clearly explains the difference between mathematical ecology and statistical ecology. The ecologists of the former category devise dynamic models such as sets of differential-difference equations. Statistical ecologists on the other hand have less faith in conceptual models and the long chains of arguments arising from them. The author is of the opinion that the mathematicians run the risk of constructing interesting models divorced from reality while the statisticians run the risk of proving clear answers to ecologically uninteresting questions. I also fall in line with the firm conviction of the author that an ecologist with

considerable field experience can recognize good questions and good answers.

The book is divided into eight chapters opening with 'Indices of diversity and evenness' which covers Simpson Index, estimation of diversity of a large community, evenness and equitability, and hierarchical diversity. Chapters two and three consisted of species-abundance distributions, followed by a testing hypothesis in chapter four. Spatial pattern, environmental gradients, local factors and global factors cover the other half of the book. A useful bibliography is presented. Conventional subject and author indexes appear as usual. To me, it appears, a little background in mathematics is necessary to apply these principles because I (basically, I am a botanist) consulted a biometrician to explain some of the steps involved. This should not frighten an ecologist from using this book. A little guidance from a mathematician will straighten your problems, if you have any. Taking into consideration all the above facts, this title is an excellent version on the topic in question. Diversity as a whole is treated in a coherent manner. It is highly desirable that a field ecologist be familiar with this type of knowledge. Undoubtedly, this is a piece of scholarly exposition by Ms. Pielou.

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Energy Flow — Its Biological Dimensions. A Summary of the IBP in Canada 1964-1974

Edited by T. W. M. Cameron and L. W. Billingsley. 1975. Royal Society of Canada, Ottawa. x + 319 pp. \$5.

The book consists of six sections corresponding to International Biological Program (IBP) outline: terrestrial productivity, terrestrial conservation, freshwater productivity, marine productivity, productivity

processes, and human adaptability. The emphasis in all the 18 chapters is on the work carried out in Canada. The opening chapter is an overview presented by W. H. Cook who had dealt with primary and secondary productivity, nitrogen fixation, terrestrial and aquatic environments, ecological sites and

reserves, and human ecology. The first section constituted the studies on productivity, primary as well as secondary, and processes such as photosynthesis and nitrogen fixation. The section on arctic ecosystem included the effects of population growth and the changing conditions on the Inuit hunting patterns, quantifies the present sources of food and economic conditions, and assesses their impact on wild life productivity. Specialized studies made in production processes, namely photosynthesis and nitrogen fixation, were dealt with in section two. The third section covered a national check-sheet survey of diverse ecological areas and indicated some representative or unique sites recommended for preservation as ecological reserves. Legal and related requirements necessary for the effective preservation of such reserves were also presented. The fourth section is on freshwater productivity for which special environments chosen are in a high arctic lake, and in a mountain lake in a more southerly latitude. Marine productivity was dealt with in section five and the projects included were from Gulf of St. Lawrence, Atlantic, Arctic, and Pacific coastal waters. All projects mostly concentrated on primary productivity. The last section is on human adaptability. It dealt with Inuit population at Igloolik and formed part of an integrated international study of the circumpolar native peoples. This study had many aspects including demography, genetics, fitness, adap-

tations, and somatic growth patterns in the Inuit. Several independent studies were consolidated in order to compare growth patterns with different segments of the Canadian population.

This book is a welcome contribution to the field of ecology and can be used as a textbook for any of the university courses. It is a fine collection of excellently written ecological contributions. The book is well edited and free of any printing errors and is recommended for research workers and postgraduate students. A complete schematic survey of IBP is presented. This is an example set forth by specialists in different fields of what we could achieve through international cooperation and standardization of methods and procedures. An integrated approach is well exemplified. It shows how scientific knowledge endeavors to improve the standard of living without exhausting the natural resources and how to maintain these perennially. Canadian participation in IBP and the results achieved are commendable. Some workers have not yet reported their projects' progress. These may throw some light when they are consolidated and published sooner or later. No doubt we all have to appreciate the efforts of Canadian research teams involved in IBP.

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The Land that Never Melts: Auyittuq National Park

Edited by Roger Wilson. 1976. Peter Martin Associates with Publishing Centre, Supply and Services Canada. 212 pp. plus map, illus \$5.95.

Auyittuq National Park on Baffin Island is dominated by glaciers flowing away from the central Penny Ice Cap, "powerful rivers of ice which have, over seemingly endless time, sculptured this panorama out of the hard rock of the peninsula." This most northerly of Canadian parks illustrates many principles of geology, as Gifford Miller and Raymond Bradley explain in the first chapter. Erratics casually scattered in the park reflect their dispersal by glaciers, striations on bedrock indicate in what direction these glaciers moved, and slow-growing lichens indicate by their size how long the glaciers have been gone. One crustose lichen was 45 mm in diameter, indicating it had been growing on a glacier-free rock for 1200 years.

The history of human occupation of the Arctic in general and of Baffin Island in particular is described in chapter 2 by Peter Schledermann who excavated a

number of sites of Thule peoples, apparently the forebears of the Inuit who arrived from the west in the Baffin area about 1200 A.D. Such archeology does not yield the electrifying finds of earlier civilizations such as the Egyptian or the Mayan, but underlines the amazing feat of how man survived at all in such a hostile climate with no modern technology. Which of us could endure an arctic winter in a stone hut roofed with skin stretched over the bones of a whale we had caught with a home-made harpoon?

Although all the many colored pictures in this book are superb, the photos of various habitats and arctic plants and the paintings of native birds by Jean-Luc Grondin in the third chapter "The Living Landscape" are even more breath-taking than usual. Patrick Baird discusses adaptations of plants that in general do not compete biologically with each other, as they do in southern Canada, but are rather pitted against their environment. Birds are easy to see and study because of the sparse vegetation, mammals less obvious except for the lemmings which every four years or so swarm

in their myriads.

The fourth chapter also by Patrick Baird gives helpful hints to park visitors — what to wear (thick clothing as a protection against cold and mosquitoes, and a lined jacket to cut the often gale-force winds); how to cross rivers with the least danger of becoming chilled; a caution not to camp on any vegetationless areas because here rockslides or snowslides probably occur.

This pocket-sized book not only provides a superb field guide for those planning to travel in southern Baffin Island, but should encourage intrepid people to visit one of our newest and most exotic national parks. I recommend it highly.

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Plants and Animals of the Pacific Northwest

By Eugene N. Kozloff. 1976. J. J. Douglass, Vancouver. 264 pp., illus. \$17.50.

The subtitle of this book reads "An Illustrated Guide to the Natural History of Western Oregon, Washington, and British Columbia." In fact, the coverage extends from Vancouver, Nanaimo on Vancouver Island, south through Puget Sound and the Willamette Valley in Washington and Oregon. The intent of the book is to act as a reference and handbook for amateur naturalists and biology students. In this task, the book gets full marks.

An earlier Kozloff book, entitled *Seashore Life of Puget Sound, the Strait of Georgia and the San Juan Archipelago*, is a companion volume and a model for the present work. In both, Kozloff approaches natural history from the standpoint of examining habitats. Chapters consider the common plants and invertebrate animals of coniferous forests, open brushy places, wet places, backyards, vacant lots, and roadsides. A concluding chapter deals with vertebrate animals, but not thoroughly since other extensive treatments are readily available. There are over 320 color photographs and 125 line drawings, all of which are clear and leave no doubt as to the identity of the organism.

The breadth of the book is impressive in terms of the number of taxonomic groups covered. Trees, shrubs, and common flowering plants are discussed, along with mosses, liverworts, ferns, and fungi. Common arthropods, snails, and slugs are also included. These are an unusual and welcome addition because these organisms are often discussed only in keys and academic tracts, largely inaccessible to

amateur naturalists. The net result of Kozloff's work is a book that is very useful and comprehensive.

Perhaps the most appealing aspect of the book is Kozloff's fresh, personal, and interesting writing style. Discussions of plants and animals come to the reader as though presented by a warm and wise old mentor. This, for the amateur, is far more appealing than dry descriptive text. Added to this is the handsome presentation of the book.

One of the problems, aside from the price, is that the book has to be read right through to be appreciated or truly useful. There are no keys, and plants and animals are not discussed as groups. If an unknown flowering plant is found, for example, the reader may have to check each chapter to find its identity. This is partially circumvented by discussions of habitats, but untrained observers cannot really be expected to be highly discriminatory in this respect. Also, the book's bulk may present a problem for field use.

Kozloff's previous book is already a standard reference for seashore life, and his *Plants and Animals* may become one as well, if it is reprinted in good paperback and reasonably priced. It will always have limited usefulness to Canadians on the west coast, especially if they live or travel farther north than the Vancouver area, but for now, it is one of the few books that offer a comprehensive natural history on the central west coast.

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NEW TITLES

Zoology

Adaptations to environment. Essays on the physiology of marine animals. 1976. Edited by R. C. Newell. Butterworths, Boston. xv + 264 pp., illus. Paper \$10.95.

†**The African buffalo.** A study of resource limitation of populations. 1977. By A. R. E. Sinclair. University of Chicago Press, Chicago. xii + 355 pp., illus. \$17.50.

***Alberta birds 1961–1970.** 1976. By T. S. Sadler and M. T. Myres. Occasional Paper Number 1. Provincial Museum of Alberta, Edmonton. \$3.25.

***An American crusade for wildlife.** 1975. By James B. Toefether. Wincester Press (Canadian distributor Nelson, Foster and Scott Willowdale). xii + 409 pp., illus. \$14.50.

†**Animal communication.** 1977. By Hubert and Mable Frings. 2nd edition. University of Oklahoma Press, Norman (Canadian distributor Burns and MacEachern, Don Mills). xi + 207 pp., illus. Paper \$6.25.

The Audubon wildlife treasury. 1976. Edited by L. Line. Lippincott, New York. 192 pp. \$15.95.

The bee book. The history and natural history of the honeybee. 1976. By Daphne More. University Books, New York. 144 pp., illus. \$12.50.

†**Biological insect pest suppression.** 1977. By H. C. Coppel and J. W. Mertins. Advanced Series in Agricultural Sciences 4. Springer-Verlag, New York. xiii + 314 pp., illus. \$29.60.

***Biology of insects.** 1976. By David J. Horn. Saunders, Philadelphia. vii + 439 pp. \$14.50.

The bird table book in colour. 1977. By Tony Soper. Illustrated by R. Gillmor. David and Charles, Newton Abbot, England. 128 pp. £2.95.

Birds as builders. 1977. By Peter Goodfellow. David and Charles, Newton Abbot, England. 160 pp., illus. £4.95.

British opisthobranch molluscs. Mollusca — Gastropoda. Keys and notes for the identification of species. 1976. By T. E. Thompson and G. H. Brown. Academic, New York. viii + 204 pp., illus. Paper \$7.65.

Crows, jays, ravens and their relatives. 1977. By Sylvia Bruce Wilmore. David and Charles, Newton Abbot, England. 192 pp., illus. £5.95.

†**The earthworms (Lumbricidae and Sparganophilidae) of Ontario.** 1977. By John W. Reynolds. Illustrated by Daniel L. Dindal. Life Sciences Miscellaneous Publications. Royal Ontario Museum, Toronto. ix + 141 pp. \$8.

Endangered and threatened amphibians and reptiles in the United States. 1976. Compiled by R. E. Ashton. Edited by S. R. Edwards and G. R. Pisani. Herpetological Circular Number 5. Society for the Study of Amphibians and Reptiles, Lawrence, Kansas. 65 pp.

†**Energetic significance of the annelids and arthropods in a Swedish grassland soil.** 1977. By T. Persson and U. Lohm. Ecological Bulletins NFR 23. Swedish Natural Science Research Council, Stockholm. 211 pp.

The ethology of predation. 1976. By E. Curio. Springer-Verlag, Berlin. x + 250 pp. \$29.60.

Fish population dynamics. 1977. Edited by J. A. Gulland. Wiley, New York. xi + 372 pp. \$25.

Fossil animal remains. Their preparation and conservation. 1976. By A. E. Rixon. Athlone, London viii + 304 pp., illus. Paper \$12.

†**A guide to bird finding east of the Mississippi.** 1977. By Olin Sewall Pettingill, Jr. Illustrated by G. M. Sutton. 2nd edition. Oxford University Press, New York. xvii + 689 pp. \$15.95.

A guide to the fishes of the temperate Atlantic coast. 1977. By Michael J. Ursin. Clarke Irwin, Toronto. Cloth \$10.75; paper \$6.75.

†**Guide to the pigeons of the world.** 1976. By Andrew McNeillie. Elsevier (Canadian distributor Burns and MacEachern, Don Mills). 160 pp., illus. Paper \$5.95.

Land hermit crabs. 1976. By Paul J. Nash. Clarke Irwin, Toronto. \$1.95.

†**Larvae of the North American caddisfly genera (Trichoptera).** 1977. By Glenn B. Wiggins. Illustrated by Anker Odum. University of Toronto Press, Toronto. xi + 401 pp. \$25.

Legion of the night: the underwing moths. 1976. By T. D. Sargent. University of Massachusetts Press, Amherst. xiii + 222 pp., illus. \$15.

The mayflies of North and Central America. 1976. By G. F. Edmunds, Jr., S. L. Jensen, and L. Berner. University of Minnesota Press, Minneapolis. x + 330 pp., illus. \$28.50.

†**Minnesota birds.** Where, when, and how many. 1975. By Janet C. Green and Robert B. Janssen. University of Minnesota Press, Minneapolis (Canadian distributor Burns and MacEachern, Don Mills). 217 pp., illus. \$9.75.

Moments of discovery: adventures with American birds. 1976. By E. Ponter and M. Harwood. Dutton, New York. \$29.95.

A natural history of marine mammals. 1976. By Victor B. Scheffer. Illustrations by Peter Parnall. Scribner, New York. xii + 158 pp. \$7.95.

†**North American bird songs — a world of music.** 1977. By Poul Bodesen. Scandinavian Science Press. Klampenborg, Denmark. 254 pp., illus. \$15.50.

Nudibranchs. 1976. By T. E. Thompson. Clarke Irwin, Toronto. Paper \$5.95.

Ontario Nest Records Scheme. 1977. By George K. Peck. Thirteenth Report (1956 — 1976). Royal Ontario Museum, Toronto and Canadian Wildlife Service, Ottawa. 34 pp.

†**Optical signals.** Animal communication and light. 1977. By Jack P. Hailman. Indiana University Press, Bloomington (Canadian distributor Fitzhenry and Whiteside, Pickering, Ontario). xix + 362 pp., illus. \$15.

†**The Passenger Pigeon.** Its natural history and extinction. 1955, 1973. By A. W. Schorger. University of Oklahoma Press, Norman. (Canadian distributor Burns and MacEachern, Don Mills). xiii + 424 pp., illus. Paper \$7.50.

†**Précis de zoologie: vertébrés.** 2. Reproduction, biologie, évolution et systématique. Agnathes, poissons, amphibiens et reptiles. 1976. Par P.-P. Grassé. 2e édition. Masson, Paris. 480 pp., illus.

†**Précis de zoologie: vertébrés.** 3. Reproduction, biologie, évolution et systématique. Oiseaux et mammifères. 1977. Par P.-P. Grassé. 2e édition. Masson, Paris. 408 pp., illus. 130F.

†**A second book of Canadian mammals.** 1977. By Charles Paul May. Illustrated by John Crosby. 2nd edition. MacMillan, Toronto. 109 pp. Paper \$4.95.

Sex lives of animals without backbones. 1976. By H. H. Najarian. Scribner, New York. x + 116 pp., illus. \$6.95.

Survey of the world's aphids. 1976. By V. F. Eastop and D. H. Rislanders. Junk, The Hague, vi + 574 pp. Dfl 160.

There's a raccoon in my parka. Adventures with wildlife in British Columbia, Alaska and the Yukon. 1977. By Lyn Hancock. Doubleday, Toronto. \$8.95.

***Waterfowl studies.** For the decoy maker and collector, hunter, bird watcher, waterfowl artist and naturalist. 1976. By Bruce Burk. Wincester (Canadian distributor Nelson, Foster and Scott, Willowdale). xiv + 254 pp., illus. \$17.95.

†**Ways of the six-footed.** A delightful introduction to the world of insects. 1977. By A. B. Comstock. Corness University Press, Ithaca. xviii + 152 pp., illus. \$5.95.

The web of adaptation: bird studies in the American tropics. 1976. Quadrangle, New York. 176 pp. \$8.95.

***Wildlife management in Europe.** 1977. By Anne Innis Dagg. Otter Press, Waterloo. ix + 324 pp. Paper \$6.50 + 50¢ postage.

Botany

Atlas of United States trees. Volume 3. Minor western hardwoods. 1976. By E. L. Little. Miscellaneous Publication Number 1314. United States Department of Agriculture, Washington. 13 pp. + 290 maps. \$9.10.

†**The Enterprise, Wisconsin radiation forest.** Radioecology studies, part 2. 1977. Edited by J. Zavitkovski. United States Technical Information Center, Oak Ridge, Tennessee. 220 pp., illus. \$7.50.

Green worlds: plants and forest life. 1976. By D. Bellamy and M. Boorer. Doubleday, Garden City, New York. 144 pp. \$14.95.

Index to plant distribution maps in North American periodicals through 1972. 1976. Compiled by W. L. Phillips and R. L. Stuckey. Hall, Boston. 686 pp.

Intermountain flora. Vascular plants of the intermountain west, U.S.A. Volume 6. Monocotyledons. 1977. By A. Cronquist, A. H. Holmgren, N. H. Holmgren, J. L. Reveal and P. K. Holmgren. Columbia University Press, New York. 584 pp. \$35.

Mount Revelstoke National Park wild flowers. 1976. By James H. Soper and Adam F. Szazawinshi. Natural History Series Number 3. National Museums of Canada, Ottawa. 96 pp., illus. \$2.50.

***Seeds and fruits of plants of eastern Canada and north-eastern United States.** 1977. By F. H. Montgomery. University of Toronto Press, Toronto. xi + 232 pp., illus. \$25.

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Cover: White-tailed Ptarmigan photographed by Donald A. Smith in the Rocky Mountains on 20 June 1968. See article on page 367.

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The Myth of the Non-Consumptive User

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The concept that some outdoor recreational activities are non-consumptive of the resource base is examined and rejected. Typical non-consumptive activities are seen to be consumptive along spatial, temporal, and physical dimensions. The wide acceptance of this erroneous concept has led to inappropriate behaviors on the part of Naturalist Club and Federation members. Serious errors in park and natural area planning and management have been made. Rejection of the concept frees us to formulate new guidelines and planning tools for parks and similar reserves. User restrictions, a proposed theory of non-use planning, and a new justification for landscape preservation are discussed within this context.

Key Words: non-consumptive user, recreation, resource base, parks, natural areas, landscape preservation.

Each year, hundreds of thousands of people participate in various outdoor recreational activities, but neither hunt nor fish, and are generally referred to as "non-consumptive" users. The purpose of this article is to cast serious doubt on the validity of this term. The perspective presented here is a policy statement adopted in principle by the Vancouver Island Region of the Federation of British Columbia Naturalists. The article was written at the suggestion of Neil Dawe, the past Regional Vice-President, and was subsequently reviewed and edited by a committee of executive officers.

In this article, consumption is discussed only in terms of outdoor recreation usually found in natural areas, parks, reserves, or conservation areas, and in unprotected semi-wilderness. Consumption in terms of what it takes to maintain the essentials of human life, such as food, water, or oxygen is not considered. The points presented here have important implications for naturalist clubs and conservation groups across Canada. It is not new to question the idea of the non-consumptive user, but there seems to have been no national discussion on the issue. Hopefully, this article will generate one.

It is easy to understand why recreational hunting and fishing are considered consumptive. Living organisms are physically removed from the scene, and consequences are apparent when populations of game decline. These resources are supposedly renewable, and can be manipulated by some sort of conventional management. Certain conservation groups, or individuals in them, often rail against consumptive forms of recreation. Naturalist groups typically cast themselves in this light. Other groups recognize and accept the consumptive nature of their activity, arguing that they merely crop off some sort of "harvestable surplus." Rod and gun clubs, rifle associations and other groups are in this category. No matter what one's particular attitude is toward hunting and fishing, there is general agreement that these are consumptive activities. They are closely regulated in terms of bag limits or in the number of licensed participants. These controls derive from the recognition of the consumptive nature of the activity, and are consistent with conventional management techniques.

By contrast, hiking or back-packing, sight-seeing, general tourism and camping in parks,

nature study, nature photography, and picnicking are clearly regarded as *non-consumptive* of the resource base. These particular activities, and all the others in this category, do not seem to remove living organisms from the scene. They are regarded as healthful pursuits that are benign in terms of the surrounding landscape. Participants in these activities are regarded as non-consumptive users of outdoor recreation resources, and consequently there are few controls governing their numbers or behavior.

The non-consumptive user can be categorized in a number of different ways according to the frequency and duration of participation in conventional non-consumptive activities. Naturalist clubs and hiking clubs which organize a specific roster of regular outings are one such category; others include the cubs, scouts, and girl guides, summer camps, wilderness users, recreation vehicle enthusiasts, etc. By far the largest category consists of all the people who camp in or otherwise visit national, provincial, or regional parks, or who, in British Columbia and other provinces, travel on logging roads and camp along the way.

It is difficult to say precisely what the size of this group is. No one can possibly guess the total number of people who visit unorganized facilities, or who seek out other sorts of crown wildland for purposes of recreation. The point is that non-consumptive users are present in far greater numbers than consumptive users. For example, in 1975, the number of hunters and anglers in British Columbia was about 512 000. No figures are available on the numbers of hunter or angler days for that year, but they could not possibly approach the 8.7 million day and overnight visits to provincial parks in British Columbia for the same year.¹ In addition, the British Columbia Forest Service provides unsupervised camping facilities throughout the province, and cannot estimate the number of people who use them. Both Crown Zellerbach and MacMillan Bloedel provide limited facilities in their timber limits, but lost count of the number of users when access to major logging

roads opened on a twenty-four hour basis a few years ago. They do estimate, however, the yearly visitation to be in the tens of thousands.

These are estimates for British Columbia alone, with a population of 2.5 million. We would surmise that the total number of "non-consumers" ranging across the landscape of all provinces and territories is staggering — far greater than park visitor statistics and participation rate data from surveys suggest. Entire industries and retail empires have been created to cater to the needs of back-packers and canoe trippers alone. The "non-consumers" are using more sophisticated and mechanized equipment every year. It is now necessary for naturalist and conservation groups to recognize that non-consumptive users are no longer a few groups of nature buffs or boy scouts hiking into the hills. They are present in this country in enormous numbers. They have become big business, and a big problem.

Is the notion of non-consumptive use valid? The very idea of it does not seem to square well with recognition that some recreational landscapes become seriously degraded over a period of time. But strangely enough, the idea has become firmly imbedded in the rhetoric of the conservation movement. Most conservation officers and professional biologists use the term to refer to groups of non-hunters and non-anglers. Even our own Federation referred to its members as non-consumptive users in a recent brief on the Fish and Wildlife Branch to the Minister of Conservation and Recreation. Perhaps it is time that we, as naturalists, escaped from this comfortable illusion.

The concept of the non-consumptive user of outdoor recreation resources is false. It is an outdated concept that appears bankrupt of accuracy. Much like the now discredited notion of multiple use, the concept may have been useful once, but now in the face of the information available, it must be discarded. In fact, because the notion of the non-consumptive user has been so widely accepted, many serious errors have been made in land-use planning and in the philosophy of the conservation movement. Here is a case in which a comfortable myth has been applied as a principle of land use, and as a result some of the major objectives of the conservation movement are in jeopardy.

¹Figures for hunters and anglers provided by G. Reid, British Columbia Fish and Wildlife Branch, Nanaimo. Figures on park use supplied by Mick Collins, Research Section, British Columbia Parks Branch.

Natural history clubs and federations have a major voice in the effective criticism of industrial, institutional, and private resource consumption issues. Until now, members of these organizations could lob their criticism from the safe fortress of the notion that their own activities were non-consumptive. But if non-consumption is a myth, then we can be held up to ridicule by our opponents.²

If so-called non-consumptive activities are not so benign, then we had better acknowledge this and get down to the serious business of re-assessing our priorities. One of the major objectives of the conservation movement, and one behind which naturalists stand firmly, is the preservation of natural landscapes and habitats. We have focused on gaining legislative protection for them without very seriously addressing the question of what happens to them next. We have not only supported the preservation of these lands, we have also been guilty of encouraging their "non-consumptive" use by our own members and the general public. In fact, the chief argument used in support of natural area preservation, except ecological reserves, is the benefit that supposedly accrues to the public in terms of recreation. This argument will have to be abandoned, particularly if clubs and federations address the contradiction of supporting both the *preservation* and *use* of natural landscapes.

Non-consumptive users do consume recreation resources along spatial, visual, and physical dimensions. They trample and re-arrange vegetation patterns, disturb wildlife, and are the chief distributors of refuse across the land. Let us discuss these and then consider some important implications of the position taken.

Spatial consumption simply means recreation consumes space. Picture a natural landscape. In order for it to be of any conventional recreational use, arrangements must be made for access to it and probably for accommodation in it. This results in the direct physical consumption of habitat in the area. A small park might serve as an illustration of this. Ivy Green Provincial Park, south of Nanaimo on Vancouver Island, is sixty-two acres in size and is bisected by the Island Highway. The park is classified as Class A or dedicated to the preservation of the natural environment (*per* the Park Act for the Province). Ivy Green contains forty-eight campsites, each about 108 m² (1200 ft²), thirty toilets and associated facilities located on pads cleared in the forest, a trailer sani-station, a paved parking lot for 104 cars, 3.5 km (2.2 mi) of roads with about 7.5-m (25-ft) clearances, and a large service yard (from the British Columbia Parks Data Handbook). All these facilities are installed for the non-consumptive user, and the process of installing them has left only about a quarter of the park unimpaired — and this is squeezed in between the campsites.

The act of providing for the accommodation of non-consumptive users has succeeded in directly consuming three-quarters of the habitat in a park which has statutory protection from impairment. In this example, the visitors do not directly remove organisms or entire habitats from the scene. The government does it for them, with our blessings. How many small parks can you think of in similar circumstances?

The problem of spatial consumption also extends to mechanized recreational vehicles. Trail bikers, waterskiers, and snowmobilers require much more space than do hikers or canoeists. Mechanized and non-mechanized pursuits rarely mix well on the same landscape at the same time because of conflicts between users. Therefore, most areas are needed to accommodate all the participants of all the various activities, and when more space is needed, it means that what was formerly available has been used up. Conflicting activities might be regulated in the same space by requiring that each occur at different times of the day or week. But this turns into a problem of regulations and controls, which appear to be unacceptable to those recreating under the

²The Village Lake Louise conflict is a good example. That was one of the major conservation victories in Canada. The environmental grounds against the proposed ski resort development were framed in terms of lost scenic and ecological amenities to non-consumptive users. The fact that it was in a national park only gave weight to our arguments. But if the project proponents, Imperial Oil et al., could have identified the long-term damage by tourists and scenery gawkers to the amenities of the site, and shown that this damage would be almost guaranteed by the management philosophy of Parks Canada, then the outcome of the conflict may have been very different. See *Nature Canada* 1(11): 35 and 1(2): 33, 1972.

illusion that their own activity is not consumptive at all.

Visual consumption means that large numbers of people consume solitude. Recreation research has confirmed that human crowding in outdoor recreation settings results in decreased satisfaction with the experience in the mind of each visitor (Lucas 1964; Stone and Taves 1956). Crowds in any particular area can build to the point where the scenic amenities of the site are completely lost by the presence of too many people. The visual and auditory impact of crowding results in a general feeling of dissatisfaction with the setting, and is often referred to as perceptual carrying capacity (Bouchard 1973; Lime and Stankey 1971). The problem is that large numbers of people (or even small numbers, depending on your degree of "purism") make solitude scarce. Since the necessary precondition of scarcity is consumption, we can conclude that visual resources have been consumed when the scenic amenities of a site are lost. If solitude becomes scarce enough to engender a feeling of over-crowding amongst people at a particular site, perceived or "expected" space has been all used up. As often as not, it is solitude that people seek when they visit natural landscapes. Here is a case in which larger numbers consume the very quality sought.

Another aspect of visual consumption is the visual impact humans have on wildlife. There are a number of wildlife species that seem to require privacy from human intrusion in order to thrive in their respective ecosystems. In these cases the presence of people may not be directly consumptive, but in the long run the result is the same. These organisms do not have somewhere else to go when they are pushed out by human presence. They are where they are because that is where they must be. The alternative for them is simply to disappear.

Beyond requirements for access and accommodation on recreational landscapes lies the problem of direct physical impact. This was first identified as a problem as early as 1929 (Bates 1935; Meinecke 1929). Subsequent studies have shown that in certain environments, such as forested areas with a well developed ground cover, very severe impacts occur with the lightest use, and that physical impact is cumulative over a period of time (Frissell and Duncan 1965; La

Page 1967). Cumulative impact simply means that the year-to-year effect of human presence in natural recreation settings continues to build gradually until serious changes become apparent. Even light and occasional use of an area for hiking or nature study can have its effect in time. The amount of effect is also dependent on the particular sensitivity of the specific site.

The direct crushing of vegetation by trampling is one factor that favors the replacement of natural vegetation by non-native basal rosette-type plants such as plantain or hawkweed. Soil compaction caused by human treading retards the growth of trees, perhaps killing them. Forest duff can be pulverized, the soil denuded, the ground can become puddled and down-slope erosion can occur. The long-term effects of these impacts are visibly and seriously to alter the original vegetation patterns and associations in a manner that normal plant succession would not. Natural vegetation patterns contribute to the characterization of the unique or valued aspects of the particular site in the first place. Furthermore, wildlife that requires special vegetational habitats will be affected. Campgrounds in some parks, for example, contain populations of Common Grackles, Brown-headed Cowbirds, and even House Sparrows. These are species not normally found in any numbers in the surrounding natural habitat.

The non-consumptive user is guilty of these impacts. Point Pelee National Park in Ontario has been hammered by birdwatchers. The impact of camping has been so great there that it is no longer allowed. Restrictions are now being placed on the number of people entering some of our large semi-wilderness parks to keep down the collective damage (and to protect the visitors' experience). North of Tofino, on the west coast of Vancouver Island, there are hot springs in Maquinna Provincial Park that are waded and bathed in by organized groups from hiking clubs. These rare hot springs are now ruined and valueless as an ecological reserve. Members of naturalist clubs are often the worst offenders in unique or highly sensitive habitats. These are areas we actively seek because of their high interest value. But we tramp around in bogs, marshes, alpine meadows, and gull colonies, content in our non-consumptive status. Increasing numbers of natural food buffs are

systematically harvesting edible wild nature. This problem is especially relevant in parks and similar reserves where the hunting or "harvesting" of other wild things is forbidden, but where groups like Outward Bound teach live-off-the-land survival skills.

The accumulation of garbage and litter in remote places is a very serious problem. Tons and tons of it are hauled out of our remote and accessible recreation areas every year (53 tons from the interior canoe routes of Algonquin Park, Ontario, in 1972 (Toronto Globe and Mail, 8 June 1974)). Imagine the garbage that piles up in the well known and easily reached areas. Garbage is not only unsightly, its presence can alter natural behavior patterns in some species of wildlife. We all know about bears and garbage, yet how can littering activity that leads to the destruction of "problem" bears be called *non-consumptive*?

Not only is it necessary to remove portions of the original countryside initially to accommodate the non-consumers, but the impact that these users have on the remainder continues year after year to erode the landscape more. The massive numbers of such users, doing their collective "thing" on our natural landscapes, makes them (i.e., us!) the *most* consumptive and the *most* destructive of all groups of recreationists. So we are faced with an interesting irony: the "non-consumers" are shown to be the most serious consumers, simply by virtue of their numbers, by what they do, and where they do it.

We must accept that the notion of non-consumptive use is a myth. There is simply no such thing as a non-consumptive user. After all, land *use* has implicit in it the idea of consumption. The idea of land use probably derives from the bizarre human misperception that all of non-human nature is merely a storehouse of resources. To say "non-consumptive use" is actually to speak a contradiction. The net result of all so-called non-consumptive recreational activity is the creation of a real scarcity of unimpaired environments. The increasing scarcity of unimpaired environments is proof of the gradual consumptive nature of our activities.

Some may find it difficult to accept the position we have taken. After all, the idea of the non-consumptive user is firmly entrenched in

our vocabularies. He has been the celebrated mythical beast that we have often used to justify landscape preservation. Under the myth we have self-righteously pointed accusing fingers at other resource consumers. We can no longer hold that somehow we are better than they are simply because we think we are non-consumptive. With a new perspective we can approach old problems with a fresh and perhaps more fruitful outlook. Let us explore some possibilities.

At least three implications come to mind if we are to reject the idea of non-consumptive uses. We must construct strict rules guiding our behavior when visiting natural landscapes. We must adopt a new attitude and approach to land-use planning as it applies to recreational landscapes. These ideas are to some extent inter-related.

Naturalist clubs must pay special attention to rules, or standards of conduct, in the outdoors. They often travel *en masse* to the most sensitive areas in their vicinity. We would recommend then that clubs make an effort to travel to special spots only very occasionally and when they do, they should travel in small groups. Choose places to go at a time of year when you'll do the least damage, and then stay on established pathways in small groups. Identify plants where they are, without picking bits off to check at home. We know a few "naturalists" who crash around looking for bird nests, and photographers who tear away the foliage for the proper camera angle. We do not say that nest records are unimportant, only that conscience often isn't part of the equipment of the recorder. Each club should recognize for itself what measures are necessary to ensure the least consumption on the part of its members.

Controls on behavior extend from the voluntary actions of clubs to the mandatory restrictions of government agencies. Nobody wants willingly to give up more liberties in a world in which they are rapidly eroding in all aspects, but it is time that naturalists begin a coordinated effort to get behavioral restrictions instituted, at least in our large semi-wilderness parks.

Strict visitor controls appropriate in large parks include party size limits, the use of burnable containers only, and the use of stoves rather than fires where natural wood is at a

premium. The ideal situation would entail licensing all back-country users and regulating their numbers through a permit system. The licensing procedure has a double benefit. It allows agencies to know how many users there are, and it could mean a skills test prior to licensing. A skills test is very important because ignorant and unskilled people are using natural landscapes more and more, and they do the most damage.

The prospect of licenses and permits for so-called "non-consumptive" users may make people recoil in horror. It conjures up the image of an enlarged bureaucracy to deal with it, as well as the spectre of more lost liberties. Back in the 1950s and 1960s, outdoor recreation of all sorts, but particularly in parks and equivalent reserves, was held to be a right, and available free to anyone. This idea has never been seriously challenged until now. The recreation we have been discussing is not a right any more; it is a privilege. We no longer live in the world of the 1960s. Solitude and wild nature are scarce. We would rather see the price for the privilege of using it paid in personal liberty than in the erosion of the unique character of the landscapes left to us. Strict controls will be made a widespread necessity anyway, when area by area, overuse becomes a crisis. If we have the vision to see that controls are necessary now, why don't we have the courage and freedom to implement them?

We have said something of the need for a new justification for landscape preservation. Total conservation is a four-part concern. Wisely managed use is just one part. Others are of equal weight and importance. They are preservation, restoration, and protection. Preservation figures importantly in overall conservation, and yet the rationale for the preservation of landscape is almost always that recreational benefits accrue to the using public. We have gone so far as to equate parks with "preserved" land, when nothing is further from the truth. If we reject the idea of the non-consumptive user, and yet recognize the importance of landscape preservation, we can hardly endorse parks as the appropriate vehicle for preservation, because parks are justified and developed for their recreational potential.

This does not mean we should reject the idea of

parks, but rather encourage governments to become serious about their stated purpose of preserving unimpaired landscapes. Neither should we reject the idea of people in parks, because there are regulatory mechanisms available to limit resource consumption by tourists and others. But we must dismiss the idea that landscapes, and the communities of life on them, can only be preserved in parks, and that the rationale of preservation is recreation. Ecological reserves and nature conservancies are a step in this direction, but so far they have succeeded in setting aside only limited areas. It simply will not do any longer to justify parks, reserves and sanctuaries in terms of the benefits to be derived for the "non-consuming" public. This form at once categorizes these landscapes as "resources" anyway, and makes their eventual exploitation for recreation an imperative.

It is sad to think that any justification is necessary at all for landscape preservation. But if it is, then we should hold that natural landscapes should exist for their own sake; that their internal dynamics are fundamental engines of nature, fueled by the sun, and nurtured by the earth. We should hold that landscapes and their internal dynamics should be preserved solely because they are there, for their own sake, and because they have the right to exist (see Stone 1974 for a discussion of the notion of legal rights for non-human nature). We must not only reject the idea that nature exists solely for human benefit, we must also develop new planning tools that are not based on human utility.

Government land agency planning proceeds along conventional lines, and clubs and federations expend considerable effort criticizing the results. We can call it "systems," or "master," or "site" planning; but what these terms really mean is the planning of how to accommodate people on the landscape. In natural areas conventional planning merely orchestrates the systematic reversal of the principles of preservation. If we recognize the consumptive nature of all recreational land uses, and are really concerned about landscape preservation, then we should reject conventional land-use planning in favor of *non-use* planning.

A new theory of non-use planning can be generated from a thorough understanding of the nature of resource consumption by recreation-

ists. It would involve the identification of physical carrying capacities on natural landscapes through detailed inventories and sampling. It would center around strict controls on the numbers and behavior of participants in supposedly non-consumptive pursuits. It would place preservation as the top priority instead of use. Finally, it would emphasize that non-human nature exists for its own sake, and that the accommodation of people in it is not a matter of compromise but rather one of integration.

In this article, a critical evaluation of the notion of non-consumptive use was made and found to be false. Some of the implications of rejecting the notion were also explored. It remains to decide what to do next. The acceptance and implementation of the various issues raised here could mark a new era for conservation in Canada. We have a choice: either we take cognizance of the future of natural landscapes and organize ourselves to meet it now, or we languish, comfortable in the hope that somebody will do something when the crisis comes. For us, the price of waiting is too high.

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Some New and Interesting Grass Records from Southern Ontario

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Locations, and remarks on ecology, distribution, and taxonomy are given for certain grasses that represent either additions to the flora or significant range extensions. These grasses range from very rare native species of unusual habitats that should be protected, to aggressive weedy species that have been introduced from Eurasia. Included are *Andropogon virginicus*, *Aristida basiramea*, *Aristida dichotoma*, *Aristida longispica*, *Aristida necopina*, *Aristida oligantha*, *Aristida purpurescens*, *Deschampsia cespitosa* var. *parviflora*, *Eragrostis spectabilis*, *Leptochloa fascicularis*, *Leptoloma cognatum*, *Muhlenbergia asperifolia*, *Panicum dichotomiflorum*, *Panicum sphaerocarpon*, *Panicum spretum*, *Panicum rigidulum*, *Poa bulbosa*, *Setaria faberi*, *Spartina patens*, *Tridens flavus*, and *Zoysia japonica*.

Key Words: grasses, Ontario, distribution, ecology, taxonomy, introduced, endangered, weeds.

We here report as new to the province of Ontario 11 species. These are *Andropogon virginicus*, *Aristida longispica*, *Aristida oligantha*, *Leptochloa fascicularis*, *Muhlenbergia asperifolia*, *Panicum spretum*, *Poa bulbosa*, *Setaria faberi*, *Spartina patens*, *Tridens flavus*, and *Zoysia japonica*. Seven of these, *Andropogon virginicus*, *Aristida longispica*, *Aristida oligantha*, *Leptochloa fascicularis*, *Setaria faberi*, *Tridens flavus*, and *Zoysia japonica* are apparently new to Canada. Ten other rare species are also discussed. Of these 21 grasses, *Andropogon virginicus*, *Aristida purpurescens*, *Panicum sphaerocarpon*, *Panicum spretum*, and *Panicum rigidulum* are certainly among our rare native species and the status of some of these in Ontario may be precarious. The stations of these species should be considered for protection. *Aristida longispica* and *Aristida necopina* are probably also very rare, but they are so inconspicuous that further investigation of suitable habitats will be necessary to determine their status precisely. *Deschampsia cespitosa* var. *parviflora*, *Leptochloa fascicularis*, *Muhlenbergia asperifolia*, *Poa bulbosa*, *Setaria faberi*, *Spartina patens*, and *Zoysia japonica* are clearly introduced species. Other species, notably *Aristida basiramea*, *Aristida dichotoma*, *Aristida oligantha*, *Eragrostis spectabilis*, *Leptoloma cognatum*, and *Tridens flavus* may well have been members of our original flora but some or all of our collections are from sites where introduction is a possibility.

Our collection localities fall into two areas of

Ontario, the Carolinian Zone (Soper 1962) and the eastern part of the Georgian Bay region in Muskoka District and Simcoe County. Records from the latter region include *Aristida basiramea*, *Panicum sphaerocarpon*, *Panicum spretum*, and *Panicum rigidulum*. Soper (1956) notes this area as a region where there is a concentration of southern species beyond the Carolinian Zone.

The species are all listed here in alphabetical order and under each are specimen citations followed by a short discussion of the species' occurrence with notes concerning ecology, general distribution, and taxonomy. All Ontario collections seen by the authors are listed except for *Panicum dichotomiflorum* and *Panicum sphaerocarpon*.

Andropogon virginicus L.

Norfolk County: Windham township, ½ mi (0.8 km) east of LaSalette, relict prairie. P. F. Maycock, O. B. Maryniak 5558, 20 May 1958 (sub. A. scoparius) (DAO, herb. P. F. Maycock).

Welland County (Regional Municipality of Niagara): Bertie Township, open coal cinders on north side of railway yards south of Jarvis Street, about ½ mi (0.8 km) west of Fort Erie North. P. M. Catling, J. L. Riley, 23 October 1976 (CAN, DAO, TRT).

Kent County: Zone township, "Thamesville Moor," east side of Florence Road (County Road 26), about ¼-½ mi (0.4-0.8 km) north of Highway 21 and northwest of Thamesville Station. P. M. Catling, L. Cwynar, B. Freedman, 26 May 1977 (DAO, TRT).

Broom-sedge, a native species with straight awns and smaller florets than *A. scoparius*, is found throughout much of the eastern and midwestern

United States (Hitchcock 1951). It is known from 11 counties in southern Michigan (Voss 1972) but has not yet been found in Ontario's southwestern counties of Essex, Lambton, and Middlesex. The Niagara record cited above represents the first record for the Niagara Frontier region (Zenkert 1934; Zenkert and Zander 1975). The Norfolk County specimen is apparently the first Canadian collection of this species and was from a native prairie habitat.

Aristida basiramea Vasey

Norfolk County: about 1.6 mi (2.6 km) west of lighthouse, Long Point. *J. E. Cruise* 7803, 6 September 1954(sub. *A. intermedia*) (DAO, TRT).

Simcoe County: Tiny township, Lot 7, Concession XVIII, 4½ mi (7.2 km) northwest of Penetang. *A. A. Reznicek* 4538, 20 August 1975 (DAO, TRT).

The Norfolk County collection was reported as *A. intermedia* (Cruise 1969). *Aristida basiramea* has been reported repeatedly from Manitoba, the first report being that of Macoun (1888), but the reports apparently have not been confirmed (Scoggan 1957) and in Canada this species is still known conclusively only from Ontario.

At the Simcoe County station *A. basiramea* is widely scattered and sometimes frequent in areas of dry bare sand in full sun, associating with *Carex rugosperma*, *Panicum depauperatum*, and *Sporobolus cryptandrus*. This station is 150 mi (245 km) farther north than any other *Aristida* record in Ontario and is the only occurrence of a species of this genus north of the Carolinian zone. In this regard it is interesting to note that *A. basiramea* is also the only species of *Aristida* to be found north of the "tension" zone in Michigan (Voss 1972).

Aristida dichotoma Michaux

Locality unknown: Three Pigeons, Canada. (NY, Photo DAO, Photo TRT). (This obscure, old record is probably not from Canada as the locality is untraceable).

Welland County (Regional Municipality of Niagara): Port Colborne. *J. C. McRae*, 1880 (MTMG, Photo DAO).

Regional Municipality of Niagara: Bertie township, railway yards, north side, south of Jarvis Street, about ½ mi (0.8 km) west of Fort Erie North. *P. M. Catling*, *J. L. Riley*, 23 October 1976 (CAN, DAO, TRT, TRTE).

The Port Colborne collection represents the oldest record of an *Aristida* species in Ontario, and was noted by Macoun (1888). At the recently discovered Fort Erie Station this species occurs by the thousands over an extensive area on open and dry coal cinders, where it was associated with the somewhat less frequent *Aristida oligantha*.

Aristida longispica Poiret

Kent County: Zone township, "Thamesville Moor," east side of Florence Road (County Road 26), about ¼–½ mi (0.4–0.8 km) north of Highway 21 and northwest of Thamesville Station. *P. M. Catling*, *A. A. Reznicek*, *S. M. McKay*, *R. Brown*, 18 September 1976 (CAN, DAO, OAC, TRT, TRTE).

This station represents the first Canadian record of this species. The plants were found in close association with *A. necopina* in open sandy soil.

Like other species of *Aristida*, this one begins to flower late in August and does not develop fruit until September or October. Even then it may be relatively inconspicuous.

Aristida necopina Shinnars (*A. intermedia* auct.)

Norfolk County (mistakenly listed as Leeds County) Longue Pointe, sur les sables découverts. *F. Marie-Victorin*, *F. Rolland-Germain*, *E. Jacques*, 8 août 1932 (sub. *A. gracilis*) (DAO).

Kent County: Zone township, "Thamesville Moor," east side of Florence Road (County Road 26) about ¼–½ mi (0.4–0.8 km) north of Highway 21 and northwest of Thamesville Station. *P. M. Catling*, *A. A. Reznicek*, *S. M. McKay*, *R. Brown*, 18 September 1976 (TRT).

Zone township, about 2 mi (3.2 km) north of Thamesville Station, on the west side of County Road 26 (to Florence). *P. M. Catling*, *A. A. Reznicek*, *S. M. McKay*, *R. Brown*, 18 September 1976 (DAO, TRT, TRTE).

The collection from Long Point in Norfolk County was reported as *Aristida intermedia* (Cruise 1969). The county given on the label of this collection is Leeds. This is clearly an error in label preparation since labels of other herbarium specimens indicate that *Victorin et al.* were on Point Pelee, Essex County, on 7 August 1932, and at St. Williams, Norfolk County, on 8 August 1932 (TRT). There are a number of Carolinian species in the 8 August Long Point collections which do not occur in Leeds County. Long Point in Norfolk County is only a few miles from St. Williams and well within the Carolinian zone.

The recently discovered stations in Kent County are characterized by open sandy soil and an open prairie-like habitat with *Danthonia spicata*, *Solidago nemoralis*, and a haircap moss (*Polytrichum* sp.). At the Thamesville moor *A. necopina* and *A. longispica* grew in close association.

Aristida oligantha Michaux

Welland County (Regional Municipality of Niagara): Bertie township, railway yards, north side, south of Jarvis Street, about ½ mi (0.8 km) west of Fort Erie North. *P. M. Catling*, *J. L. Riley*, 23 October 1976 (CAN, DAO, TRT, TRTE).

This is the first Canadian record. A few hundred plants were found in dry coal cinders in the open. Associates included other rare grass species such as *Andropogon virginicus*, *Aristida dichotoma*, *Eragrostis spectabilis*, and *Leptoloma cognatum*.

Aristida purpurescens Poiret

Essex County: Ojibway Prairie, Windsor, *W. Botham*, 8 September 1968 (herb. W. Botham).

Dry prairie at Ojibway, south of Windsor, *P. F. Maycock*, 24 October 1969 (Photocopy DAO).

South of Windsor, "LaSalle" prairie, west of Highway 18 behind Naminco Factory, *P. W. Ball*, *P. F. Maycock* 68271a, 9 September 1971 (TRTE). South of Windsor, Ojibway prairie, Matchette Road, south end, west side, *P. W. Ball*, *P. F. Maycock* 70471a, 10 September 1971 (TRTE).

Windsor prairie, east of Windsor Raceway and Ojibway Park, *P. M. Catling*, *S. M. McKay*, 21 September 1975 (TRT).

Dodge (1914) reported this species from dry ground on Squirrel Island in Lambton County, but it was not found there in Gaiser's later survey (Gaiser and Moore 1966), nor has it been encountered there since. We have found it to be relatively frequent in the drier parts of the relict prairies south of Windsor but it was not recorded there by either Rogers (1966) or Thompson (1975). *Aristida purpurescens* becomes conspicuous only in late summer and autumn, and is usually not apparent by persistent remains, despite its perennial habit and relatively large size.

Deschampsia cespitosa (L.) Beauv. var. *parviflora* (Thuill.) Coss. & Germ.

Perth County: 4 mi (6.4 km) northwest of Stratford along Highway 8, *W. G. Dore*, *H. A. Senn* 47-430, 30 July 1947 (DAO, TRT).

Carleton County: about 2 mi (3.2 km) above Billings Bridge, Ottawa, *W. G. Dore* 13600, 29 September 1951 (DAO).

Simcoe County: Essex township, Lot 22, Concession VI, 4½ mi (7.2 km) southeast of Angus, *A. A. Reznicek* 4533, 6 September 1975 (DAO, TRT).

The widespread species *Deschampsia cespitosa*, represented by var. *glauca* (Hartm.) Lindm. f. is, throughout southern Ontario, a local and delicate species of calcareous shores and limestone plains. It is only rarely a weed of disturbed sites. *Deschampsia cespitosa* var. *parviflora*, introduced from Europe, is a locally aggressive colonizer of ruderal sites. It is a tall variety, frequently to 1 m, with large panicles, long flat leaves and small spikelets averaging 2.5–3.0 mm long with the first glume 1.9–2.7 mm and the second glume 2.3–2.6 mm (in the material cited above).

This variety was reported as locally established in New England long ago (Fernald 1926). It is also

known from the Maritime provinces (Roland and Smith 1963–64; DAO) and Quebec (Boivin 1967; DAO). The Carleton County station, probably resulting from persistence in an old garden (Dore 1959), appears to have been destroyed (Dore, personal communication). An extensive stand was found in the ditch along Highway 8 near Stratford, and the Simcoe County station is similarly in moist open sandy ditches along a road. *Deschampsia cespitosa* var. *parviflora* is as yet very rare in Ontario.

Eragrostis spectabilis (Pursh) Steudel

Frontenac County: Sharbot Lake, 1.5 mi (2.4 km) southwest, about 50 clumps along railroad shoulder. *W. G. Dore* 13871, 31 July 1952 (DAO).

Oxford County: Woodstock, sandy ground, lawn of park on Ingersoll Avenue. *F. H. Montgomery*, *W. Shumovich*, 14 September 1953 (DAO, OAC, TRT).

Kent County: open sandy ground, about 4 mi (6.4 km) north of Bothwell on north side of road west of railway crossing. *P. M. Catling*, *A. A. Reznicek*, *S. M. McKay*, *R. Brown*, 18 September 1976 (TRT).

Welland County (Regional Municipality of Niagara): Bertie township, dry open cinders and gravel, north side of railway yards south of Jarvis Street, about ½ mi (0.8 km) west of Fort Erie North. *P. M. Catling*, *J. L. Riley*, 23 October 1976 (CAN, DAO, TRT).

This is our only perennial *Eragrostis* species. It has a hard knotty base and large purplish inflorescence which is readily detached at maturity, acting as a tumbleweed. The inflorescence is larger than our annual members of the genus, 19–30 cm long and 15–26 cm wide in specimens from the locations cited above.

Called "Tumble-grass," "Purple Lovegrass" and, interestingly, "Petticoat-climber," this grass was first reported from sandy beaches on Pelee Island (Core 1948). In addition to the collections cited above, it has also been reported for Elgin County (*W. G. Stewart* 1972, unpublished data) and Essex County (Thompson 1975).

It is widespread in the lower peninsula of Michigan (Voss 1972), and throughout the eastern, midwestern, and part of the southwestern United States (Fernald 1950). Undoubtedly it will be found elsewhere in Ontario. The collections cited above represent the first records for Kent County and for the Niagara Frontier region (Zenkert 1934; Zenkert and Zander 1975). Elsewhere in Canada, *E. spectabilis* is known only from southwestern Quebec (Boivin 1967).

This grass may well be native in prairie-like habitats on the Bothwell sand plain in Kent County and in the Windsor prairie (Thompson 1975).

Leptochloa fascicularis (Lam.) Gray

District Municipality of Niagara: Montrose railway yard, south side of Niagara Falls. *P. M. Catling, K. L. McIntosh*, 27 September 1976 (CAN, DAO, TRT, TRTE).

Salt Meadow Grass is found in brackish marshes along the Atlantic coast and on alkaline flats in western North America (Hitchcock 1951), but is rare inland in the east and has not previously been reported for Canada.

It occurs inland in New York State mostly in the vicinity of salt springs and salt factories (Wiegand and Eames 1925) but also in railway yards (Zenkert and Zander 1975). It has also been found in Michigan (Stephenson 1967). The occurrence of this species in railway yards is usually associated with the stockpiling or transport of salt, and with the use of salt to melt ice and snow on the switches and elsewhere in the yards.

The plants cited above have the second glume 3.5–4.3 mm long and awns 0.9–1.2 mm long. They are referable to var. *acuminata* (Nash) Gleason, which has western affinities (Gleason and Cronquist 1963). This grass has been frequently called *Diplachne acuminata* (Fernald 1950).

Leptoloma cognatum (Schultes) Chase

Peel County: prairie remnant beside railway, Lorne Park. *P. W. Ball*, 22 September 1971 (TRTE).

Welland County (Regional Municipality of Niagara): Bertie township, dry open cinder and gravel, north side of railway yards, south of Jarvis Street, about ½ mi (0.8 km) west of Fort Erie North. *P. M. Catling, J. L. Riley*, 23 October 1976 (CAN, DAO, TRT, TRTE).

Widely distributed in southern Michigan (Voss 1972) and scattered through New York State (Zenkert and Zander 1975), it appears that the records cited above represent the second and third records for the province. It was first reported in Ontario from Rockhouse Point in Haldimand County (Zenkert and Zander 1975).

Fall Witchgrass occurs throughout most of the eastern and midwestern United States. It is apparently native to the west and south, but may be only adventive in the northeast, where it has a more scattered distribution (Hitchcock 1951; Gleason and Cronquist 1963).

From a distance this grass resembles *Panicum capillare* or *Muhlenbergia asperifolia*. The membranous ligule, nearly obsolete first glume, and long second glume, and the narrowly elliptic shape of the spikelets are helpful in recognition.

Muhlenbergia asperifolia (Nees and Meyen) Parodi
Essex County: east of Windsor Salt factory, Windsor.

P. M. Catling, S. M. McKay, 18 August 1975 (CAN, DAO, TRT).

District Municipality of Niagara: south side of Niagara Falls, Montrose railway yard. *P. M. Catling, K. L. McIntosh*, 27 September 1976 (CAN, DAO, TRT).

In both of the above localities the plants were found in several large patches on open and highly alkaline soil.

These are the first Ontario records and may be the first records for northeastern North America. *Muhlenbergia asperifolia* is found in alkaline prairies, sloughs and ditches in western North America. Hitchcock (1951) lists New York as part of its range, but does not map this species east of Indiana. It has not been reported from Michigan (Voss 1972). Elsewhere in Canada this species is found from southern Manitoba to British Columbia (Scoggan 1957; Boivin 1967).

Panicum dichotomiflorum Michaux

Peel County: Toronto township (city of Mississauga), ½ mi (0.8 km) south of junction of Dundas Street (Highway 5) and Mississauga Road, on south bank of Credit River. *A. A. Reznicek, D. R. Gregory*, 27 October 1975 (TRTE).

Welland County (Regional Municipality of Niagara): Grantham township, open alkaline median of the Queen Elizabeth Highway at St. Catharines. *P. M. Catling, K. L. McIntosh*, 10 September 1976 (TRT).

(Regional Municipality of Niagara): Niagara Falls, open alkaline soil, Montrose railway yard on south side of town. *P. M. Catling, K. L. McIntosh*, 27 September 1976 (TRT).

(Regional Municipality of Niagara): Bertie township, railway yards north side, south of Jarvis Street, about ½ mi (0.8 km) west of Fort Erie North. *P. M. Catling, J. L. Riley*, 23 October 1976 (CAN, DAO, TRT).

York County: East Toronto, open soil along a zinc fence, Lakeshore and Leslie intersection. *P. M. Catling, B. Freedman*, 24 October 1976 (CAN, DAO, TRT).

Although a native of eastern North America, this late-flowering annual has weedy tendencies. It appears to have spread into rural and cultivated lands in extreme southwestern Ontario about 1920. Until recently it was considered a relatively uncommon plant known only from the southwest and from the far eastern parts of Ontario in the Ottawa and St. Lawrence lowlands where it was first noticed in 1949. Only recently was it reported from the Canadian portion of the Niagara Frontier region (Yaki 1970; Zenkert and Zander 1975). Our recent field work has disclosed that this species is now quite

frequent and, in fact, a serious weed of cornfields in the extreme southwest. Its weedy nature has been documented by Alex and Switzer (1976). *Panicum dichotomiflorum*, or at least this ecotype (which may be of recent origin), is a tough plant tolerant of extremely dry, exposed habitats with levels of certain metals in the soil that would be toxic to many plants. Not surprisingly it appears to be spreading.

Most of the specimens cited above may be clearly segregated as var. *geniculatum* (Wood) Fern.

Panicum rigidulum Nees

Hastings County: about 1 mi (1.6 km) south of Stoco.

W. G. Dore 13490, 15 August 1951. (sub. *P. agrostoides*) (DAO).

On shore of Moira River at the bridge, Stoco.
W. G. Dore 13493, 15 August 1951 (sub. *P. agrostoides*) (DAO).

Wet rocky flood-shore of bay of Stoco Lake,
Tweed. W. G. Dore 13496, 15 August 1951 (sub. *P. agrostoides*) (DAO).

Muskoka District: Wood township, Concession VI,
Lot 37, Hurling Point, 1 mi (1.6 km) west of Bala.

R. E. Whiting, L. Jewitt 1437, 23 August 1972 (sub.

P. agrostoides) (herb. R. E. Whiting, TRT).

Morrison township, VIII-31, northeastern shore of Sparrow Lake, 4.3 km west southwest of Kilworthy Station. A. A. Reznicek, R. Bobbette 2391, 7 September 1975 (herb. R. E. Whiting, TRT).

This very rare species is apparently native on rocky shores near the southern edge of the Canadian Shield (Figure 1). The two recent Muskoka collections are both from crevices in Precambrian rock directly on the shores of lakes. They were not widely separated and the species is likely scattered on other, similar shores in this region. The plant is reported by Stroud (1941) from Wellington County, Ontario, apparently based on a specimen alleged to be from Guelph: "meadows and pastures, Guelph, Ontario, L. McDougall, July 1937" (DAO). It is very likely that the specimen has been mislabelled as per annotations on the sheet by W. G. Dore and B. Boivin. *Panicum rigidulum* is unknown elsewhere in eastern Canada, but was reported long ago from British Columbia (Macoun 1888). It is known from five counties in southern Michigan (Voss 1972) and is reported from North Bass Island in western Lake Erie (Core 1948). This would seem to make its presence in extreme southwestern Ontario a possibility.



FIGURE 1. Wet rocky flood-shore habitat of *Panicum rigidulum*. Photographed at Stoco Lake, near Tweed, Hastings County, 15 August 1951 (DAO), by W. G. Dore.

This species is known in many floras (Fernald 1950; Gleason 1952) as *P. agrostoides*, a fitting but illegitimate name (Voss 1966).

In view of the fact that we also discuss the occurrence of *Leptoloma cognatum* in Ontario, it should be noted that one of the key characters often used to separate *Leptoloma* from *Panicum* is the membranaceous ligule of *Leptoloma* as contrasted with the ring of hairs or obsolete ligule of *Panicum* (Shinners 1944; Fassett 1951). *Panicum rigidulum*, however, has a distinctive, membranaceous, erose ligule quite different from other Ontario *Panicum* species.

Panicum sphaerocarpon Ell.

Simcoe County: North Orillia township, Concession X, Lot 24, Matchedash Lake, 10 mi (16 km) northeast of Coldwater. *A. A. Reznicek* 4543, 27 August 1976 (DAO, TRT).

Kent County: Zone township, "Thamesville Moor," east side of Florence Road, County Road 26, about ¼–½ mi (0.4–0.8 km) north of Highway 21, northwest of Thamesville Station. *P. M. Catling, A. A. Reznicek, S. M. McKay, R. Brown*, 18 September 1976 (DAO, TRT).

This infrequent southern species of moist-to-dry sandy sites was known from a number of collections in Essex, Kent, Lambton, and Middlesex Counties in southwestern Ontario. It was also reported for Elgin County by W. G. Stewart (1972, unpublished data). Our second collection adds a site in northern Kent County near the Middlesex County border. In addition, the collection from Simcoe County represents a range extension of about 170 mi (275 km) from the nearest Ontario site for the species. It occurs here on the sandy shores of Matchedash Lake with a host of other interesting species as described in the article under *Panicum spretum*.

Panicum sphaerocarpon does not occur north of the "tension" zone in Michigan (Voss 1972). Thus, the Simcoe County disjunction is probably real and not an artifact due to lack of collecting of *Panicum*. *Panicum sphaerocarpon* has nevertheless been overlooked in parts of southern Ontario. We have found it at several additional locations in Kent County, and we were surprised to find that its occurrence had not been documented at any of these sites before.

Panicum sphaerocarpon is quite distinctive in its interesting juxtaposition of very small spikelets with wide leaves, up to 19 mm in the Simcoe County material. The leaves of the conspicuous fall rosettes are especially broad with many strong nerves.

Panicum spretum Schultes

Simcoe County: North Orillia township, Lot 24, Concession IX, Matchedash Lake, 9½ mi (15.3 km)

northeast of Coldwater. *A. A. Reznicek*, 30 June 1975 (DAO).

Matchedash Lake, *P. W. Ball* 26575, 30 June 1975 (TRTE).

Matchedash township, Lot 1, Concession VIII, Matchedash Lake, 8 mi (12.9 km) northeast of Coldwater. *A. A. Reznicek* 4544, 13 August 1976 (TRT).

Muskoka District: Wood township, Lot 16, Concession XIV, Nine-mile Lake. *P. F. Maycock*, 23 October 1976 (herb. *P. F. Maycock*, Erindale College).

This primarily coastal-plain species was first found in Ontario on drying sandy lakeshores in Simcoe County in 1975 and subsequently in nearby Muskoka District in 1976. It is one of the coastal plain species discussed by Voss (1972) who noted that it is very rare in Michigan. The only other Canadian sites of this species are in southern Nova Scotia (Dore and Roland 1942; Roland and Smith 1969).

When robust, the species may be up to 1 m tall and is unmistakable on the sandy lakeshore. *Panicum spretum* may be distinguished from related species of *Panicum* in the region by its size, glabrous foliage and sheaths, long ligule and narrow panicle.

In its sandy lakeshore habitat, *Panicum spretum* occurs with other rare plants, some of which are also of eastern and coastal affinity. These include *Rhexia virginica*, *Linum striatum*, *Muhlenbergia uniflora*, *Fimbristylis autumnalis*, *Panicum sphaerocarpon*, *Rhynchospora capitellata*, *Polygonum careyi*, and *Xyris difformis*.

Poa bulbosa L.

Peel County: Mississauga township, several scattered clumps along 10 yards of steep, recently disturbed sandy bank, north side of Highway 5, east of Mississauga Road, community of Erindale. *A. A. Reznicek* 3778, 27 May 1972 (DAO, TRT, TRTE). Mississauga township, roadside, Erindale, *P. W. Ball* 2132, 14 May 1973 (TRTE).

Mississauga township, dry gravelly roadside bank, southwest corner of interchange of Queen Elizabeth Highway and Mississauga Road, Mississauga. *A. A. Reznicek* 4545, 29 May 1975 (TRT, TRTE).

York County: West Toronto, edge of disturbed path to woods, off Royal York Road, north of bridge, southwest edge of Lambton Woods. *E. Hamilton*, 3 June 1976 (TRT).

Bulbous Bluegrass, introduced from Europe, is a very distinctive species with the florets converted to bulblets with dark purple bases. It is widespread in western North America (Hitchcock and Cronquist 1973) and in Canada, frequent in the Victoria region of British Columbia (Szcawinski and Harrison 1973). In eastern North America, it is very local and

scattered, having been reported from New York, Virginia, and North Carolina (Hitchcock 1951).

These are the first collections of this species growing without cultivation in Ontario. The records are all from the Toronto region, and may indicate a developing local infestation. The collections cited above may be referred to *P. bulbosa* var. *vivipara* Koeler. A specimen at OAC labelled "waste places; Kemptville, Ontario; 1939" is believed to be mislabelled (W. G. Dore, personal communication).

Setaria faberi Herrm.

District Municipality of Niagara: Montrose railway yard, south side of Niagara Falls. *P. M. Catling, K. L. McIntosh*, 27 September 1976 (CAN, OAC, TRT).

Welland County (Regional Municipality of Niagara): Bertie township, north side of railway yards south of Jarvis Street, about ½ mi (0.8 km) west of Fort Erie North. *P. M. Catling, J. L. Riley*, 23 October 1976 (CAN, DAO, TRT).

York County: Metropolitan Toronto, along a railway, Don Valley, north of Bloor viaduct, opposite brickyard. *P. M. Catling, J. Kaiser, S. M. McKay*, 28 September 1976 (CAN, DAO, TRT).

Metropolitan Toronto, along a railway track, south of Wicksteed Avenue, East York. *P. M. Catling, J. Kaiser, K. L. McIntosh, S. M. McKay*, 1 October 1976 (CAN, DAO, OAC, TRT).

East Toronto, along C.N. railway tracks in the railway yard between Victoria Park Avenue and Main Street, near old Danforth Station. *P. M. Catling, S. M. McKay, K. L. McIntosh*, 3 October 1976 (CAN, TRT).

These are the first records for Ontario for this introduced Asian species. It is spreading aggressively in the northeastern and midwestern United States (Reed 1970). In Ontario, it occurs now as one of a characteristic group of plants, such as *Plantago psyllium* and *Chaenorrhinum minus* that are found mainly in gravel and/or coal cinders and clay in open locations along railways, and especially in railway yards (Figure 2).

This species resembles *S. viridis* but differs in having a strongly nodding panicle (up to 14 cm long) bent below the middle, spikelets mostly over 2.5 mm long, the fertile lemma more or less tapering to a distinctly exposed tip, and leaf blades more or less hairy above (Voss 1972). In addition, it is tetraploid while *S. viridis* is diploid (Pohl 1962). Pohl (1962) has also pointed out that the blades are not always hairy, but in all of our material cited above the upper leaf blades are distinctly hairy. In depauperate plants the panicles may not be long enough to curve over, and are often quite erect. Also, depauperate specimens may have only one flower per panicle branch, giving

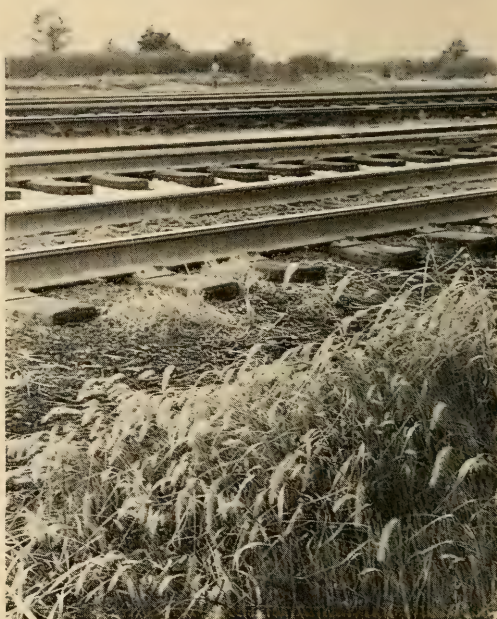


FIGURE 2. A patch of *Setaria faberi* with characteristic nodding, spike-like panicles. These plants were growing in cinders and gravel along a railway track at Fort Erie North, District Municipality of Niagara. Photographed 23 October 1976 by P. M. Catling.

the impression of as many as 10 spines per floret only because the other florets have not developed. The latter phenomena also occurs towards the base of longer spikes, so that the use of bristle number is an unreliable identification feature. Even in depauperate material of *S. faberi*, the short second glume covers only three quarters to five sixths of the fertile lemma, instead of 9/10 as in *S. viridis*, and the prominent cross-ridges of the fertile lemma contrast with the minutely papillose lemmas of *S. viridis* (often spotted with dark brown). Depauperate plants of *S. faberi* (to 20 cm tall) have spikelets 3 mm long compared to similarly sized plants of *S. viridis* with spikelets only 2 mm.

Spartina patens (Ait.) Muhl.

Essex County: City of Windsor, immediately south of Windsor Salt factory (Sandwich Avenue and Prospect Avenue). *P. M. Catling, S. M. McKay*, 17 May 1975 (CAN, DAO, TRT).

Windsor Salt factory, Windsor. *P. M. Catling, S. M. McKay*, 21 September 1975 (CAN, DAO, TRT).

These represent the first records of Salt-meadow Cordgrass for Ontario. The plants were found with other halophytes such as *Solidago sempervirens* and *Juncus gerardii* in open alkaline soil. *Spartina patens* is a characteristic species of salt marshes along the Atlantic coast with isolated inland stations previously known in New York and Michigan (Hitchcock 1951; Mobberley 1956; Voss 1972) where, like *Leptochloa fascicularis*, it occurs about sodium-salt springs, salt factories, and railway yards.

Tridens flavus (L.) Hitchc.

Regional Municipality of Niagara: Montrose railway yard, south side of Niagara Falls. P. M. Catling, K. L. McIntosh, 27 September 1976 (CAN, DAO, TRT).

Purpletop is widespread in the eastern and mid-western United States (Hitchcock 1951) and has long been expected in Ontario, this being the first record. It may have been formerly native in the Niagara peninsula and in extreme southwestern Ontario. It has not been reported elsewhere in Canada.

A tall (1–1.5 m) attractive species, Purpletop may be readily overlooked owing to its superficial similarity to *Panicum virgatum* L. It differs in having the deep purplish spikelets 6- to 8-flowered. This grass is sometimes placed in the genus *Triodia* (Fernald 1950; Gleason 1952).

Zoysia japonica Steudel

Essex County: Mersea township, Point Pelee, W. Botham, 11 June 1972 (herb. W. Botham).

Point Pelee National Park, just north of the Nature Interpretation Centre. A. A. Reznicek, P. F. Maycock, D. R. Gregory, 13 July 1976 (TRT, TRTE).

This Asiatic species, and cultivars of it, have been recorded from lawns several times in the past from Ottawa, Windsor, and Kitchener (various collections, DAO and OAC). In these cases, it would appear to have been part of the sod or seed used to establish the lawns. In many instances *Zoysia* is an undesirable lawn grass. In Ontario at least it remains brown much later into the spring than other species and turns brown much earlier in the autumn.

The collection cited from Point Pelee was not associated with a lawn. It grew in openings in a *Juniperus virginiana* glade on dry, sandy soil with *Poa compressa*, *Sporobolus cryptandrus*, *Aster azureus*, *Euphorbia corollata*, *Rhus typhina*, *Opuntia compressa*, and *Cornus racemosa*. The *Zoysia* in this colony had flowered well, in comparison with the vegetative condition of almost all other herbarium collections. Although there were formerly cottages in the vicinity, this collection was not associated with their grounds and may well represent a natural establishment rather than a planting.

Acknowledgments

We thank W. G. Dore and J. McNeill for considerable help with records of rare species and for allowing us to consult their manuscript on Ontario grasses (1977). B. Boivin helped with herbarium records. We also here express our gratitude to P. W. Ball, W. Botham, P. F. Maycock, and R. E. Whiting for allowing us to cite some of their recent collections. R. Brown kindly showed us some very interesting localities in his local area of Kent and Lambton Counties, and this led to a number of discoveries. Finally, S. McKay and K. McIntosh both shared in the discoveries of several species, and for their assistance we are very grateful.

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Addendum

Andropogon virginicus L.

Kent County: Camden township, Lot 2, Concession II, about 2 mi (3.2 km) west of Dresden, *P. M. Catling* and *R. Brown*, 16 August 1977 (DAO, TRT).

Howard township, on north side of Highway 401 at Interchange 13, about 6 mi (9.6 km) south of Thamesville in Concession VI, *P. M. Catling*, *K. L. McIntosh* and *S. M. McKay*, 27 August 1977 (DAO, TRT).

Zone Township, Lot 6, Concession VIII, northwest side of Highway 2, about 3 mi (4.8 km) southwest of Bothwell, *P. M. Catling* and *R. Brown*, 27 August 1977 (DAO, TRT).

Since it was first noticed in Ontario in 1976, this grass has been found at several localities on the Bothwell sand plain in Kent and Middlesex Counties. A selection of new localities is cited above.

Crypsis (Heleochoa) schoenoides (L.) Lam.

Essex County: City of Windsor, south of the salt factory near Prospect Ave. and Sandwich Ave., *P. M. Catling* and *K. L. McIntosh*, 20 Sept. 1977 (DAO, TRT).

A native of the Mediterranean region, this grass is known from various parts of the northeastern U.S. (Hitchcock 1951; Gleason and Cronquist 1963). It was first discovered in Ontario by J. W. Wilson of Windsor during the late summer of 1977. About 50 plants were found in moist organic soil (pH 7.5) of a ditch south of the Windsor salt factory. The plants grew in association with *Cyperus odoratus*, *Pluchea purpurascens*, and *Spartina patens*.

Leptoloma cognatum (Schultes) Chase

Kent County: Zone township, Lot 5, Concession III, along the Canadian Pacific Railway west of

Highway 23, *P. M. Catling* and *R. Brown*, 16 August 1977 (DAO, TRT).

At least 50 plants of Fall Witchgrass were found here in dry open sandy ground (pH 5.6) associating with *Ambrosia psilostachya*, *Solidago nemoralis*, *Danthonia spicata*, and *Eragrostis spectabilis*. This represents the first record for Kent County and the fourth record for Ontario.

***Setaria faberi* Herrm.**

Kent County: Dover township, north side of the mouth of the Thames River near Bradley's Farms, *P. M. Catling*, 16 August 1977 (TRT).

Camden township, Lot 2, Concession II, about 2 mi (3.2 km) west of Dresden, *P. M. Catling* and *R. Brown*, 27 August 1977 (DAO, TRT).

Chatham township, Lot 30, Concession I, about 4 mi (6.4 km) west of Dresden at Turner's Pond, *P. M. Catling* and *R. Brown*, 27 August 1977 (DAO, TRT).

Previously we stated that in Ontario this plant belongs to a group of species encountered mainly along railways. This is certainly true for parts of the province, but during our recent explorations of Kent County it was frequently found along the edges of fields of tomatoes, corn, and soybeans (specimens cited above). Here it associates with other weedy species such as *Setaria viridis*, *Abutilon theophrasti*, *Panicum capillare*, *Solanum nigrum*, and *Chenopodium album*.

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Terrestrial Oligochaeta of Some New Brunswick Caves with Remarks on Their Ecology

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McAlpine, Donald F. and John W. Reynolds. 1977. Terrestrial Oligochaeta of some New Brunswick caves with remarks on their ecology. *Canadian Field-Naturalist* 91(4): 360-366.

Cave faunas are poorly known in eastern Canada. An examination of six caves and one abandoned mine in three New Brunswick counties revealed that four of the caves and the mine harbored earthworms (Annelida, Clitellata, Oligochaeta, Lumbricidae). Most frequently encountered were *Dendrodrilus rubidus* (Savigny) and *Aporrectodea tuberculata* (Eisen). *Dendrodrilus rubidus* seems to be the common cave earthworm in Canada as well as in the United States. Both of these species seem to be reproducing in the mine examined. There is no indication whether the other two species collected, *Eisenia rosea* (Savigny) and *Lumbricus terrestris* L., are established as troglophiles. The initial introduction of earthworms to caves or mines may have been accidental, e.g., through the actions of weather or man, but active colonization may play as important a role. The structure of the entrance to the cave or mine probably controls the primary method of earthworm introduction.

Les faunas caves sont très peu connues à l'Est du Canada. Une recherche dans six caves et dans une mine abandonnée dans trois comtés du Nouveau-Brunswick a révélé que quatre des caves et la mine sont hébergées de vers de terre (Annelida, Clitellata, Oligochaeta, Lumbricidae). Les plus fréquemment trouvés furent *Dendrodrilus rubidus* (Savigny) et *Aporrectodea tuberculata* (Eisen). *Dendrodrilus rubidus* semble être le plus commun des vers de terre des caves au Canada et même aux Etats-Unis. Ces deux espèces semblent se propager dans la mine examinée. Il n'y a aucune indication que les deux espèces collectionnées, *Eisenia rosea* (Savigny) et *Lumbricus terrestris* L., sont établies comme troglophiles. L'introduction initiale des vers de terre dans les caves et dans les mines peut être accidentel soit par des actes de la température ou de l'homme. La colonisation active peut aussi jouer un rôle important. La structure de l'entrée de la cave et de la mine contrôle probablement la méthode primaire de l'introduction des vers de terre.

Key Words: caves, New Brunswick, ecology, distribution, earthworms, *Aporrectodea tuberculata*, *Dendrodrilus rubidus*, *Lumbricus terrestris*.

Previous faunal investigations of Canadian caves have only briefly made mention of earthworms. Halliday and Dunnet (1966) note *Dendrodrilus rubidus* (Savigny) was collected in Skull Creek Cave on Vancouver Island. (In a reprint of their paper a typographical error in the synonym used for the specific name of the species has *rubida* recorded as *tubida*. In noting this record the error was repeated by Peck and Fenton (1973) in a summary paper on the fauna of Canadian caves.) Calder and Bleakney (1965) found earthworms uncommon in their study of the microarthropod ecology of Frenchman's Cave, a porcupine-inhabited gypsum cave in Nova Scotia. The specimens they collected were not identified (Calder and Bleakney 1967). Recently, Reynolds (1977) has recorded *D. rubidus*, one of the 19 Ontario species, from mines in that province. It appears that the occurrence of *Aporrectodea tuberculata* (Eisen) in New Brunswick caves, recorded here, is the first published record of this species in such a habitat in North America. In many ways this

may be owing to the past taxonomic problems in the trapezoides complex which have only recently been unravelled by Gates (1972). Gates (1959) reported *A. tuberculata* may have been recorded from caves in Germany as *Allolobophora caliginosa* (Savigny).

Although from the subsurface habitat earthworms normally occupy they would appear pre-adapted to the cave environment, they have not been one of the more successful troglobite³ groups. Vandel (1966) noted that troglitic terricoles have been described from Japan and Assam and recently Zicsi (1974) described a cavernicolous lumbricid from a subaquatic habitat in Hungary. No troglitic terricoles have been recorded from Canadian or American caves, though a number of limnicolles have been recently described from caves in the United States (Cook 1975).

All earthworms in regions glaciated during the

³Animals that normally complete their life cycle only in caves; often showing specialized adaptations for cave life.

Quaternary were exterminated and all megadriles (= terrestrial oligochaetes) now present in these regions have been recently introduced by man (Gates 1970; Reynolds 1975, 1976a). Therefore, troglobic terrioles could not have evolved in the short time period since first European colonization of New Brunswick. Caves in this province appear too shallow to have served as refugia during the glacial period.

As trogloneic⁴ and troglophilic,⁵ earthworms have been more successful. Gates (1959) recorded 12 species from caves in the United States but gives no indication whether actual populations were involved, stating only that those earthworms collected were surface forms. Most of the forms that Gates (1959) examined were parthenogenetic, a character considered favorable to the colonization of a new area (Reynolds 1974). Gates (1959) noted that a single cocoon of some obligatory biparental species may give rise to a number of individuals. He felt that this, and the fact that copulation may be completed prior to the introduction into the new area, might indicate something other than that the reproductive mode may be of primary importance in the establishment of troglophilic earthworm populations.

Nicholas (1960) has noted the difficulty in determining the extent of cave adaption exhibited by earthworms.

Methods

Investigations were carried out in six caves and one mine in Albert, Kings, and Saint John Counties of New Brunswick. All specimens were collected by hand-sorting through soil, detritus, gravel, and dung samples. Rocks and pieces of wood were overturned and sections of tree trunk and mine support beams were often split and examined. Details on habitat and zonation (dark or threshold zone) were recorded.

Results and Discussion

Four of the six caves and the mine were occupied by earthworms. From the 27 specimens collected, we identified 4 of the 14 species present in this province (Reynolds 1976b; Reynolds and

Christie 1977). A number of the worms collected were too young to be identified to species. These all belonged to the genus *Aporrectodea* and are probably *tuberculata* since this was the only species of this genus obtained from the New Brunswick caves. *Aporrectodea tuberculata* is also the dominant earthworm species in Canada (Reynolds 1977).

Table 1 records the data on the earthworm species collected at each location sampled. Earthworms were not abundant in any of the caves or mine ($\bar{x} = 5.4$). Although no attempt was made to assess the total number of worms that each cave harbored, seven specimens was the maximum number of worms obtained by hand-collecting methods in any one cave. Gates (1959) probably encountered similar results since the mean number per cave based on the 173 earthworms he examined from 23 caves was 7.5. Although other methods of collection, in conjunction with the hand-sorting technique used in this study, might have revealed greater numbers in some cases, they would have caused great disruption to the cave ecosystem.

The cave/mine lengths examined ranged from 14 m to 122 m. Relative to the area of each cave, only a small amount of detritus is washed in. The amount of detritus rather than the length of the cave or mine appears to have a greater bearing on the number of earthworms at each site.

Table 1 shows that although Harbells Cave is much longer than Glebe Pot, many more earthworms were encountered in the latter. A sizeable stream runs through Harbells Cave and little detritus collects in this cave. Glebe Pot, on the other hand, collects and retains a great deal of detritus and large numbers of fallen leaves, both potential habitat and food material for earthworms.

Greenhead Cave is also longer than Glebe Pot. The entrance to Greenhead Cave, however, is on a cliff face and the exit is blocked by ceiling collapse. Virtually no detritus enters this cave and no earthworms were discovered though the cave was carefully searched.

The source of energy and habitat material in Bat Cave is principally porcupine droppings, which are not favored by earthworms. No other significant amount of detritus appears to enter this cave, but more diligent searching may reveal

⁴Animals that frequently enter caves but do not complete their life cycle in caves.

⁵Animals that may complete their life cycle in caves but normally do so in suitable habitats outside of caves.

TABLE 1—Species and collection data for earthworms in New Brunswick caves in threshold zone (th) or dark zone (dk)

Cave location	Main passage length (m)	Date	Earthworm species	Number of specimens	Zone	Habitat
Glebe Pot, Kings Co.	14	18 Sept. 1976	<i>Lumbricus terrestris</i>	1	dk	Under rock in mud
		19 Sept. 1976	<i>Aporrectodea tuberculata</i>	2	th	Under rotten log
		3 Oct. 1976	<i>Dendrodrilus rubidus</i>	2	dk	In detritus
Glebe Mine, Kings Co.	122	3 Oct. 1976	<i>Aporrectodea tuberculata</i>	2	dk	Under rock in mud
		28 Aug. 1976	<i>Lumbricus terrestris</i>	1	dk	Under mine timber
		28 Aug. 1976	<i>Dendrodrilus rubidus</i>	2	dk	Crack in fallen mine timber
		17 Oct. 1976	<i>Aporrectodea</i> sp.	2	dk	In soil under rock
		17 Oct. 1976	<i>Aporrectodea</i> sp.	1	dk	Porcupine dung
Kitts Cave, Kings Co.	100	6 Mar. 1976	<i>Aporrectodea</i> sp.	2	dk	In soil
Harbells Cave, Saint John Co.	unsurveyed ≈60	25 Jul. 1976	<i>Aporrectodea</i> sp.	2	dk	Under mine scat
		23 Oct. 1976	<i>Aporrectodea tuberculata</i>	1	th	Crawling on wall of entrance
		23 Oct. 1976	<i>Aporrectodea tuberculata</i>	1	dk	Under rock in mud
		15 Mar. 1975	<i>Aporrectodea tuberculata</i>	1	dk	Detritus in small pocket in wall of chamber
Saint John Co.	≈80	10 Oct. 1976	<i>Dendrodrilus rubidus</i>	3	dk	Under logs
		10 Oct. 1976	<i>Eisenia rosea</i>	1	dk	Under logs
		9 Jan. 1977	<i>Dendrodrilus rubidus</i>	1	dk	Ceiling of dome (see Fig. 1)
		22 Aug. 1976		0	th	Wet gravel
		23 Aug. 1976		0	dk	Under block breakdown
Greenhead Cave, Saint John Co.	≈45	14 Nov. 1976		0	th	Gravel, mud detritus
Bat Cave, Albert Co.	unsurveyed ≈45	14 Nov. 1976		0	dk	Detritus, porcupine dung

earthworms at this site. It is worth noting that McAlpine found Bat Cave low in both abundance and diversity of all species of invertebrate fauna.

Table 1 also shows that most of the worms were concentrated in the dark zone. The probable reason is that most of the detritus seems to collect here. Earthworms were collected in the threshold zone only in Glebe Pot where water runs over the entrance lip and collects the detritus at the bottom of the shaft, and in Harbells Cave, which has a muddy threshold zone that merges with the forest floor.

The dark zone offers the most stable environment in the cave. The soils and detritus of the threshold zone, when present, are usually shallow and offer earthworms little protection from damaging sunlight. The dark zone, however, has the coldest mean annual temperature of any part of the cave, and this is not an immediate asset to earthworm reproduction or development of troglophilic populations.

The porcupine, *Erethizon dorsatum*, commonly dens in many caves in the Maritimes. Its large dung piles are a major source of energy and support a varied invertebrate community (Calder and Bleakney 1965) in many caves in this region. Of the hypogean environments examined, Glebe Mine and Bat Cave served as porcupine denning sites. Calder and Bleakney (1965) felt that the acidity of cave detritus, principally porcupine dung, was a factor limiting the presence of earthworms in Frenchman's Cave. Samples of porcupine dung in Frenchman's Cave ranged from a pH (1:1 H₂O) of 5.1 in poorly decomposed detritus to 6.3 in thoroughly decomposed feces.

Although the present investigations revealed only one immature *Aporrectodea* sp. from dung samples, work on pH tolerance among earthworms (Bodenheimer 1935; Wherry 1924) would indicate considerable variation in acidity tolerance between species.

Reynolds (1977) states that *D. rubidus* seems quite acid tolerant. He notes that *A. tuberculata* has been recorded from soils of pH 4.8–7.5, *Eisenia rosea* (Savigny) from soils of pH 4.9–8.0, and *Lumbricus terrestris* L. from soils of pH 4.0–8.1. It does not seem that soil reaction per se is the factor limiting earthworm colonization of caves.

Manure piles harbor, from time to time, all the species collected in this study (Reynolds 1977). These feces, however, are composed primarily of partially digested plant material that the earthworms normally feed on. Porcupines, in contrast, feed largely on the cambium layer of various trees and on conifers in particular. Reynolds and Jordan (1975) rank conifers lowest on the earthworm palatability scale. Porcupine dung could then be considered close to unpalatable for earthworms. This may be a better explanation of why these feces appear to be a marginal habitat for the oligochaetes encountered in caves and mines in New Brunswick.

Stone and Ogles (1953) noted that high concentrations of the mite *Uropoda agitans* may limit earthworm populations. Calder and Bleakney (1965) found that poorly decomposed porcupine dung supported high populations of Acarina, averaging 67.3/100 cc of this detritus. They did not record the above mite species, but their collection was not completely identified (Calder and Bleakney 1967). Further collections of mites from caves in Nova Scotia and New Brunswick by Moseley (1974, 1975) have not revealed this species.

In the cave environment earthworms are certainly not exposed to a wide variety of predators as are epigeal forms. McLeod (1954) reported the staphylinid beetle *Quedius mesomelinus* as a predator of earthworms. This insect has been collected in Kitts Cave (Moseley 1975), and McAlpine has noted a staphylinid, possibly this species, in Glebe Mine.

It appears that the smoky shrew, *Sorex fumeus*, occasionally enters caves in this area (McAlpine 1976) and on one trip to Glebe Mine McAlpine observed a deer mouse, *Peromyscus maniculatus*, in the dark zone. Although Hamilton (1941) has found that earthworms make up a relatively insignificant part of the diets of these two mammals, they likely consume any earthworms they discover while foraging in caves or mines.

Earthworms are probably commonly introduced with seasonal runoff into those caves that get a seasonal influx of detritus after heavy rains in spring or autumn. Gates' (1961) division of megadrile species, based on their food habits, is of interest. He considered *D. rubidus* a litter feeder. He termed the other three species



FIGURE 1. *Dendrodrilus rubidus* crawling on the ceiling dome of Howes Cave, New Brunswick.

collected in this study geophagous (those species that pass much soil through their intestines). If such is the case, *D. rubidus* would be more commonly at the soil surface and most prone to be washed into caves.

Earthworms may also enter caves or mines under their own power. *Dendrodrilus rubidus* seems to be an active species. Reynolds (1977) reported that on damp nights it has been noted crawling on the surface of the ground and even climbing trees. In Glebe Mine, earthworm cocoons and castings, probably of *D. rubidus*, were observed on ceiling beams. In Howes Cave a specimen of *D. rubidus* was collected from the ceiling of a small dome (see Figure 1). A single specimen of *A. tuberculata* was noted crawling about 20 cm above the ground on the damp wall of the threshold zone in the entrance to Harbells Cave. This same species was collected in the dark zone of this cave. In Glebe Mine, which does not receive the same seasonal influx of plant detritus with runoff as do the caves, active colonization may be of some importance in earthworm introduction.

In the particular case of mines man may play as important a role in introducing earthworms to the habitat as do seasonal weather patterns. In

Glebe Mine, the only food available to earthworms in any great quantity in the dark zone are support timbers, both standing and fallen. If these had been stored outside for a while, it is not difficult to understand how earthworms or their cocoons could have been transported into the mine with clumps of soil adhering to the beams. The mine was opened about 100 years ago.

Voisin (1961) found the optimum soil temperature for a number of earthworm species, two of which were collected in this study. Optimum soil temperatures for *D. rubidus* are 18–20°C and for *E. rosea*, 12°C. Interestingly, these two worms represent the extremes of the optimum soil temperatures for the seven species he examined. Bodenheimer (1935), working with *Allolobophora samarigera* Rosa, found the range of normal activity to be 14.7–27.8°C. He found only "interrupted crawling" at 14.7°C, "only weak movements" at 6.7°C, and the "beginning of cold torpor" at -1.3°C.

Reynolds (1977) and Gates (1961) have noted that earthworms may be active under ice and snow or in litter surrounded by snow. Specimens of *D. rubidus* have been collected in breeding condition from a ridge of soil surrounded by 75 cm of snow. This cold weather activity would

indicate that local populations may at least be pre-adapted enough to remain normally active in caves and mines when introduced into these environments. The work by Voisin (1961) would indicate that some study is needed to determine whether all megadrile species collected in this investigation are able to reproduce in Maritime caves and mines without a period of acclimatization. Reynolds (1977) noted that estivation and hibernation are climatically imposed in Ontario for the four species collected in this study, with reproduction being limited to autumn and spring. McAlpine has noted ice in the outer dark zone of some New Brunswick caves in July.

Brief observations on air temperatures in caves in southern New Brunswick by McAlpine and more detailed work by Calder and Bleakney (1965) in Nova Scotia have revealed that cave air temperatures in the constant-temperature zone hover around 3–4°C in both regions. It is generally known that cave air temperatures in this zone approximate the mean annual surface temperatures for the areas in which they are situated. Due to the short length of many New Brunswick caves constant temperature zones may not be present in all caves. Calder and Bleakney (1965) found temperature readings to be 1°C cooler 5 cm below the surface of detritus than in the adjacent air.

Although some acclimatization may take place, a temperature of 4°C must affect the reproductive and metabolic rates of earthworms in caves, and under these temperature conditions it would appear that earthworms would neither reproduce quickly nor require large food supplies of detritus.

Dendrodrilus rubidus was very often associated with branches on the cave floor or mine support beams. Reynolds frequently encounters this species in northeastern North America under the bark of decaying logs. *Dendrodrilus rubidus* was collected a number of times from within cracks in fallen beams. When associated with timbers, *A. tuberculata* was beneath them in the detritus or shallow soils. Usually *A. tuberculata* was collected from pockets of detritus or in mud under rocks. It was interesting to note that in Kitts Cave, where beaver (*Castor canadensis*) have constructed dams and stored caches

of *Salix* and *Alnus* (McAlpine 1977), two favored earthworm foods (Reynolds and Jordan 1975), *D. rubidus* was associated with these beaver caches.

Conclusions

The origin of cavernicolous megadrile populations are commonly accidental, through the actions of weather or man, but may be through active colonization. The structure of the entrance to the cave or mine probably controls whether passive or active modes of colonization are of prime importance in the introduction of earthworms to any given cave or mine. Once the initial introduction has been made, reproduction may or may not take place. In New Brunswick, annual seasonal introductions of individuals with detritus may ensure the presence of earthworms within the cave from year to year even though the earthworms may not be reproducing in the caves. These earthworms could be considered troglonexic. Evidence presented earlier that *D. rubidus* is reproducing within Glebe Mine would indicate that some individuals of this species are troglophilic. The immature *A. tuberculata* collected from dung samples in the mine lend support to the conclusion that this species may also be reproducing in Glebe Mine.

It is also worth considering whether earthworm reproduction in New Brunswick caves is limited to the variable-temperature zone initially. Although this cave zone is much cooler during the summer months than are nearby epigeal earthworm habitats, its mean annual high temperature is above that of the constant-temperature zone. Acclimatization may still be necessary, but the demanded reproductive adaptation to temperature would not be as severe as in the deeper and colder parts of the cave or mine.

Gates (1959) has reported *D. rubidus* to be the common cave earthworm in the United States. It was the only species he reported from a mine in that country and it has been collected in mines in Canada and France as well. *Dendrodrilus rubidus* is a litter form, prone to be washed into caves, is commonly associated with logs (Reynolds 1977) and mine support beams, is easily introduced to caves and mines by man, and appears to crawl actively some distances over the ground surface. These may be reasons to explain

why it is so commonly encountered in both caves and mines.

In Britain *Eiseniella tetraedra* (Savigny) is the most common earthworm in caves (Reynolds 1977). Although the species has been recorded in New Brunswick (Reynolds 1976b), it has not been collected in any of the counties where caves in this study are located, or in any Canadian caves.

Based on the information presented here and the limited work of others on the topic, *D. rubidus* seems to be the common Canadian cave earthworm.

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Summer Habitat Use by White-tailed Ptarmigan in Southwestern Alberta

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Periodic censuses of White-tailed Ptarmigan (*Lagopus leucurus*) in alpine basins of southwestern Alberta between 15 July and 31 August 1976, provided information on habitats used during the summer season. Birds occupied areas in which rocks covered about half of the ground surface and where water was available within 25 m. Willows (*Salix* spp.), mosses (Bryophyta), grasses (Poaceae), saxifrage (*Saxifraga* spp.), sedges (*Carex* spp.), groundsel (*Senecio* spp.), cinquefoil (*Potentilla* spp.), and everlasting (*Antennaria* spp.) were the major components of vegetation in areas used by ptarmigan. Males and broodless females moved away from breeding ranges in late July; females with broods remained on the breeding range but frequently travelled downhill along stream courses even below treeline. The cause of this apparent segregation and its extent are unknown.

Key Words: White-tailed Ptarmigan, summer habitat, Alberta.

White-tailed Ptarmigan occupy alpine areas with an abundance of rock and low-growing vegetation during the summer season (Weeden 1959; Choate 1963; Braun 1971). In Colorado most males and broodless females move from breeding areas at lower limits of the alpine tundra upslope in early July to higher ridges where late-lying snowfields provide sufficient moisture to support vegetation used as food (Braun 1971). Females with broods also move upslope during the summer, but generally remain at somewhat lower elevations; sedges (*Carex* spp.), avens (*Geum* spp.), and clovers (*Trifolium* spp.) are common plants in the areas used by all birds (Braun 1971). Choate (1963) also observed ptarmigan following the retreating snow upslope during the summer months. He recorded snow willow (*Salix nivalis*), heaths (*Cassiope* spp. and *Phyllodoce* spp.), and mosses as the dominant plants at sites where ptarmigan were observed from early June to mid-September.

These study areas in Colorado and Montana are characterized by large expanses of gently rolling alpine tundra (Choate 1963; Braun and Rogers 1971). Conversely, in southwestern Alberta, White-tailed Ptarmigan breed in small alpine basins above which relief is steep and vegetation immediately upslope rapidly becomes sparse. Terraces of alpine tundra, which might provide late-lying snowfields, do not exist. Habitat use varies with geologic situations, thus this study was undertaken to determine the vegetative components of ptarmigan summer

habitat in southwestern Alberta and whether the sexes differed in their use of habitat.

Study Areas

Ptarmigan were censused in the Rocky Mountains Forest Reserve approximately 9-10 km east of Kananaskis Lakes and 42 km west of Turner Valley, Alberta, at elevations of 2170-2640 m. Three areas were chosen for study: Burns Lake (50°36' N, 114°57' W), Highwood Pass (50°36' N, 114°59' W), and the basin between Elpoca and Tombstone Mountains locally known as Goat Valley (50°40' N, 115°02' W). These areas provide a mixture of krumholz, rock slides, cliffs, willow shrubs, and large herbaceous mats of heather (*Cassiope tetragona*), heath (*Phyllodoce glanduliflora*), and mountain avens (*Dryas hookeriana*). Streams, which flow throughout the summer, drain these basins; snowfields rarely persist past mid-July.

Methods

Study areas were searched for ptarmigan at intervals of 7 to 10 days from 15 July to 31 August 1976. Birds were located by systematically searching all cover with the aid of pointing dogs. Some bias in the census technique occurred, as an attempt was made to capture all unmarked birds encountered; thus more time was spent in areas where birds previously had been located. I believe this bias is small, because all areas were searched thoroughly, and a special effort was made in areas where ptarmigan sign

TABLE 1—Percent cover by rocks, water, and various species of plants in habitat used by White-tailed Ptarmigan during the summer season (15 to 31 August 1976). Data from 82 census plots. Others include all species with frequencies less than 15%

Vegetation	Frequency of occurrence (%)	Average cover (%)
Rocks	100	49
Water	45	6
Mosses (Bryophyta)	78	8
Grasses (Poaceae)	73	4
Saxifrage (<i>Saxifraga lyalli</i> , <i>S. bronchialis</i> , and <i>S. oppositifolia</i>)	65	10
Snow Willow (<i>Salix nivalis</i>)	61	10
Sedge (<i>Carex</i> spp.)	61	5
Groundsel (<i>Senecio lugens</i> and <i>S. triangularis</i>)	60	3
Cinquefoil (<i>Potentilla diversifolia</i> and <i>P. fruticosa</i>)	60	1
Arctic Willow (<i>Salix arctica</i>)	54	20
Everlasting (<i>Antennaria alpina</i> var. <i>media</i> and <i>A. lanata</i>)	50	2
Common Yarrow (<i>Achillea millefolium</i>)	45	2
Drummond's Anemone (<i>Anemone drummondii</i>)	45	1
Moss Campion (<i>Silene acaulis</i>)	38	2
Flea-bane (<i>Erigeron aureus</i> , <i>E. humulis</i> , and <i>E. grandiflorus</i>)	37	1
Fireweed (<i>Epilobium alpinum</i> and <i>E. latifolium</i>)	32	3
Alpine Speedwell (<i>Veronica alpina</i>)	30	1
Grass-of-Parnassus (<i>Parnassia montanensis</i>)	29	2
Mountain Sorrel (<i>Oxyria digyna</i>)	27	6
Indian Paintbrush (<i>Castilleja occidentalis</i>)	26	1
Alpine Forget-me-not (<i>Myosotis alpestris</i>)	22	1
<i>Smelowskia calycina</i>	21	2
Heart-leaved Arnica (<i>Arnica cordifolia</i>)	21	5
Mountain Avens (<i>Dryas hookeriana</i>)	18	22
Rock Willow (<i>Salix vestita</i>)	17	9
Milk Vetch (<i>Astragalus occidentalis</i>)	17	2
<i>Saussurea densa</i>	16	1
Snow Buttercup (<i>Ranunculus eschscholtzii</i>)	16	1
Yellow Mountain Heath (<i>Phyllodoce glanduliflora</i>)	15	11
Others [Elephant Head (<i>Pedicularis groenlandica</i>), Stonecrop (<i>Sedum rosea</i> and <i>S. stenopetalum</i>), Blue-green Gentian (<i>Gentiana glauca</i>), Sandwort (<i>Arenaria sajanensis</i>), Dwarf Alpine Dandelion (<i>Taraxacum lyratum</i>), Rocky Mountain Goldenrod (<i>Solidago multiradiata</i>), Sweet-flowered Androsace (<i>Androsace chamaejasme</i>), Slender Blue Beard-tongue (<i>Penstemon procerus</i>), <i>Hedysarum sulphurescens</i> , White Camas (<i>Zygadenus elegans</i>), Rocky Mountain White Heather (<i>Cassiope tetragona</i>), Wild Strawberry (<i>Fragaria virginiana</i>), Low Larkspur (<i>Delphinium bicolor</i>), and Horsetail (<i>Equisetum scirpoides</i>)]	—	—

(feathers and/or droppings) was found but birds were not observed.

A circular plot of 50 m² (ca. 4.0 m radius) was centered on the point of location where an individual bird was first sighted. The location of the female was chosen as plot center for females with broods. The presence and relative abundance of all species of plants within the plot were determined. Plants were identified using the flora by Moss (1959), and the percent coverage

of individual species was visually estimated to the nearest 5% (2.5 m²). Species comprising less than 5% coverage of the plot were recorded as being present and were assigned a value of 1% in quantitative summaries.

The distance of ptarmigan locations to the nearest willow shrub greater than 30 cm in height, coniferous cover, and source of water (snowfield, stream, or lake) was recorded to determine the extent to which these habitat

TABLE 2—Number of sightings (%) of White-tailed Ptarmigan within 25 m of nearest water source, willow cover greater than 30 cm in height, coniferous cover, and the mean distance (m) \pm SD to these habitat features. Sightings of females with broods (N=48) and without broods (N = 7) are summarized separately

Habitat feature	No. of sightings < 25 m (%)				Mean distance (m) \pm 1 SD			
	Males (N = 27)	Females (N = 48)	Females (N = 7)	Total	Males (N = 27)	Females (N = 48)	Females (N = 7)	Average
Water	19(70)	42(88)	6(85)	67(82)	8 \pm 6	7 \pm 8	10 \pm 6	7 \pm 7
Willow	7(26)	29(60)	0(0)	36(44)	11 \pm 11	12 \pm 7	—	12 \pm 7
Conifer	4(15)	13(27)	0(0)	17(21)	8 \pm 7	16 \pm 9	—	14 \pm 8

features might influence ptarmigan distribution. Distances up to 100 m were recorded to the nearest meter; habitat features beyond 100 m were recorded as being distant and were not included in quantitative analysis.

Results and Discussion

Ptarmigan were seldom located far from boulders and/or rock slides; rocks occurred with both the highest frequency (100%) and percent coverage (49%) in the census plots (Table 1). Rocks provide essential cover for these ptarmigan, and birds are usually observed in areas where rocks are greater than 30 cm (12 in) in diameter (Weeden 1959; Choate 1963; Braun 1971). Similarly, with the exception of males located late in summer, ptarmigan were usually located within 25 m of a snowfield, stream, or lake (82% of all sightings) (Table 2). Thus, ptarmigan were concentrated along stream courses with an abundance of rocks (Figure 1) and were rarely observed in areas that did not provide both rocks and moisture (e.g., foreground, Figure 2). Willow shrubs and conifers (*Picea* spp., *Abies* spp., and *Pinus* spp.) greater than 30 m (12 in) in height were considered as alternate sources of potential cover (Table 2). As they travelled along streambanks females with broods were often in close proximity to willow shrubs (mean distance of 12 m, 60% of all sightings), but birds did not crouch in this vegetation when disturbed. Ptarmigan preferred to escape by running and/or flying, or to remain motionless near rocks at the water's edge. No group of birds was associated with coniferous cover to any degree (Table 2). These results confirm the observations of Choate (1963) that ptarmigan are rarely found in vegetation taller than themselves, and thus are dependent almost

solely on rocks for cover presumably from inclement weather and predators. Rocks also trap drifting snow, which might provide moisture for plants as the summer progresses.

The presence and abundance of species of vegetation in habitat used by ptarmigan are presented in Table 1. Willows, grasses, sedges, cinquefoil, and everlasting were main components of the vegetation; mosses, saxifrage, and groundsel were also very common, and reflect the moist conditions where ptarmigan were found (Table 1). In contrast to Choate's (1963) study area, heath and heather were minor components of the vegetation at my sites. Weeden (1959) also rarely observed White-tailed Ptarmigan in such vegetation, and although large mats of heath, heather, and mountain avens were present in my study areas, birds avoided these areas (e.g., foreground, Figure 2). These sites were typically open with few boulders and were very dry early in summer. Weeden (1959) also thought broods might have difficulty travelling through dense vegetation (heath and heather) and so avoided these areas. Several species of plants were present regularly (Table 1) but contributed little to the total coverage of census plots owing to their nature of growth and relative abundance.

Vegetation at census plots was similar for male and female ptarmigan, and results were combined in Table 1. But 18 of the 27 sightings of males (67%) occurred prior to 7 August when males were still occupying breeding range. After 7 August, males were located on only nine occasions; four of these sightings were high on windswept ridges where vegetation was sparse (Figure 2) and the other five occurred on 29 and 30 August near to the July areas. Only seven



FIGURE 1. Streamside habitat used by all White-tailed Ptarmigan in early summer and by females with broods throughout the summer.

sightings were obtained of females without broods and these all occurred prior to 1 August. More observations of males and broodless females are needed in mid- and late summer to determine whether there are significant differences between the type of vegetation used by these groups and females with broods.

Movement away from spring territories by male and broodless female ptarmigan to higher elevations has been reported in Montana and Colorado (Choate 1963; Braun 1971). Observations of males high on ridges in August, the failure to locate any males in the Goat Valley study area after 3 August, and the inability to locate leg-banded individuals other than females with broods after 7 August provide evidence for summer movements away from breeding areas in southwestern Alberta. Extensive movements to higher elevations above breeding areas may not be possible because of the geologic structure of the Rocky Mountains in this part of the bird's range; individuals may move to distant basins at higher altitudes. The summer movements of males and broodless females is an intriguing problem for future research.

Females with broods occupied the same areas throughout the summer and concentrated their activities along streambanks (Table 2). Unlike the situation elsewhere of females with broods gradually moving upslope to higher elevations (Choate 1963; Braun 1971), females with broods



FIGURE 2. Dry alpine habitat typical of areas not used by White-tailed Ptarmigan during the summer. Male ptarmigan were located on the high ridge in the background on three occasions in mid-summer.

in this study frequently moved downslope along stream courses (often below tree-line). In areas intensively grazed by livestock, horizontal and downhill movement by both sexes of ptarmigan can occur (Braun 1971).

The presence of certain species of plants in census plots used by ptarmigan may reflect food habits to some degree. Weeden (1967) found the leaves of willows and buttercups (*Ranunculus* spp.), seeds of sedges and grasses, and fruits of bistorts (*Polygonum* spp.) to be common items in the diet of adult ptarmigan in summer. May and Braun (1972) agreed with these findings and indicated that females selectively fed on bistorts while males ate the seeds and leaves of plants according to their availability, including clovers (*Trifolium* spp.), mouse-ear (*Cerastium* spp.), mustards (Cruciferae), snowball saxifrage (*Saxifraga rhomboidea*), and alpine avens (*Geum rossii*). Bistorts, clovers, and alpine avens were not present in my study areas and alternate food items are probably selected; females with broods were observed feeding repeatedly on the flowers and leaves of *Smelowskia calycina* (Cruciferae), a food item not previously recorded (Weeden 1967; May and Braun 1972). As suggested by May and Braun (1972), ptarmigan distribution in summer may be closely related to the availability of green vegetation, and indeed differences in food habits between the sexes may influence habitat selection.

In summary, alpine areas with an abundance of rocks for cover, and where sufficient moisture for the growth of fresh vegetation is available, are used during the summer by White-tailed Ptarmigan in southwestern Alberta. All birds use these spring breeding areas to meet habitat requirements early in summer; females with broods continue to use these areas throughout the summer. I believe this use constitutes selection because wide expanses of potential habitat are avoided. A definite segregation of

habitat type occurs in mid-summer: males and females without broods move away from breeding basins (possibly to distant basins of higher elevation), but females with broods remain along stream courses, frequently traveling downstream below tree-line. The extent of seasonal movements is unknown, and the reason different members of the sexes segregate into different habitat is not apparent.

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Horned Grebe Breeding Habitat in Saskatchewan Parklands

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Distribution of Horned Grebes, *Podiceps auritus*, on a 31.1-km² area with 25 ponds per km² was measured in 1974 and 1975. Before, and particularly during, the nesting season the grebes tended to select permanent ponds over 0.2 ha that had areas without emergent vegetation. Distribution was not affected by tree growth around ponds, but prior to nesting the birds showed some preference for ponds surrounded by pasture rather than cultivated fields. There were 47 nests on 47 ponds (1.5 nests per km²) in 1974, and 103 nests on 102 ponds (3.3 nests per km²) in 1975.

Key Words: Horned Grebe, *Podiceps auritus*, breeding habitat, nesting, Saskatchewan, parklands.

Habitat used by breeding Horned Grebes (*Podiceps auritus*) has been studied in detail in Norway, Iceland, and Finland by Fjeldså (1973a, b), and has been described for a grassland area in North Dakota (Faaborg 1976), but quantitative descriptions are lacking for parkland habitat where, in North America, the species apparently reaches its highest densities. With increasing pressure on wildlife habitat from other land uses, data on habitat requirements should be gathered and documented for bird species that may be threatened by loss of habitat. This study documents nest densities and describes the habitat used by Horned Grebes on a study area in Saskatchewan during 1974 and 1975.

Study Area

The study area (52°N, 106°W) is a block, 4.83 × 6.44 km, 48 km east of Saskatoon. It is divided by roads and fencelines into 12 sections, each 2.59 km² (1 mi²), and these were used as sampling units. The block comprises Sections 14–17, 20–23, and 26–29 of Township 36, Range 28, West 2. The area is in the aspen parkland (Bird 1961), soils are dark brown, and topography is rolling to gently rolling (Mitchell et al. 1947). Annual precipitation averages about 36 cm. Land use on the study area was exemplified by 1975 percentages: grain (barley and wheat), 41.5; summer fallow, 29.4; rapeseed, 5.9; pasture, 6.1, about one-half of which was grazed; farmyards and roads, 1.2; wasteland (chiefly uncultivated areas around ponds), 6.3; and ponds, 9.6. Pond density averaged 25/km². Size ranged from less than 0.04 ha to 8.1 ha.

Most ponds were partly or wholly bordered with trees, mainly willows (*Salix* spp.) and trembling aspen (*Populus tremuloides*). Limnological data for the ponds are lacking; however, these ponds are similar to the numerous closed, eutrophic, freshwater ponds found throughout the prairie-parkland region (Driver 1977; Driver and Peden 1977).

The wetland vegetation on the area followed closely the lists given by Millar (1976, p. 22) for species found in various freshwater vegetation zones of prairie wetlands. One exception was the scarcity of *Scirpus* spp. on my area. The most common emergent species occurring in ponds used by grebes were *Typha latifolia*, *Scolochloa festuacea*, and *Carex atherodes*.

Methods

Maximum depth of ponds was measured in early May and again in July. Ponds were assigned to permanency categories similar to those described by Martin et al. (1953) and Evans and Black (1956). Type 1 ponds are shallow depressions, seldom having over 25 cm of water and, except in wet years, dry up before July. Type 3 ponds are shallow marshes usually not more than 60 cm deep. These ponds also tend to dry up during summer except in wet years. Type 1 and 3 ponds that contain water through the growing season usually become overgrown with emergent vegetation. Type 4 ponds have up to 120 cm of water in the spring and seldom become dry. Growth of emergent vegetation such as *Scolochloa* and *Carex* leaves little or no open water by July. Type 5 ponds are over 120 cm

deep in spring and contain water even in dry years. Emergent vegetation usually occurs only around the pond margin and a majority of the area remains open. This is the main distinction between Type 4 and Type 5 ponds. Pond areas were measured from maps prepared from aerial photographs. For data analysis, ponds were assigned to six area classes: < 0.21; 0.21–0.40; 0.41–0.81; 0.82–1.62; 1.63–3.24; > 3.24 ha. Similarly, the percentage of shoreline bordered by trees (mainly *Salix* spp.) was measured and each pond was assigned to one of three categories of woody shore growth: open, 0–33%; half-open, 34–66%; and closed, 67–100% (Smith 1971). Land use around ponds was recorded in late May as summer fallow, seeded to grain, seeded to oilseed, or as pasture.

Horned Grebes were censused three times in May each year. Each pond was visited in one day between 0830 and 1530 hours by one of four people making the census. From late May to late July, all ponds were searched twice for nests. Eggs in a nest, or, on some occasions, a brood on a pond were criteria used to establish the presence of a nest.

The effect of the different pond variables on the distribution of birds and nests was tested with chi-square.

Results and Discussion

Some Habitat Features

Figures for the numbers of ponds by permanency type and size class in 1974 and 1975 were pooled (see Table 2). For each category, numbers in the two years were similar. Mean area of Type 1 ponds was 0.07 ha; Type 3, 0.15 ha; Type 4, 0.42 ha; and Type 5 ponds, 1.17 ha. Because Type 1 and 3 ponds received negligible use by grebes, they were excluded from further analyses. Numbers of Types 4 and 5 ponds per 259-ha section varied from about 13 to 58 in both years. The total numbers of Types 4 and 5 ponds were 455 and 453 in 1974 and 1975, respectively. Percentages of ponds in the three categories of peripheral tree growth were similar in both years: 43% open, 14% half-open, and 43% closed. Water levels were above average during the study and much of the peripheral tree growth was inundated throughout the nesting seasons.

Pre-nesting Distribution

Numbers of ponds occupied and numbers of Horned Grebes seen during May counts in 1974 and 1975 are given in Table 1. Results of counts are comparable to the extent that the same technique was used throughout. Some birds were probably missed during counts, particularly on ponds with extensive flooded willows. At times Horned Grebes on open water swam into such cover when alarmed. Some of the single birds seen probably represented pairs. Also, nests were found on some ponds where no birds had been seen during counts suggesting that they had been missed, though movement onto such ponds after counts could not be ruled out. For these reasons the figures can be used only as population indices. Because more than one nest on a pond was a rarity, the number of ponds on which one or more birds was seen perhaps would be the best index to breeding pairs in the absence of data for nest densities. The first count in 1974 and the last in 1975 were chronologically similar and therefore were compared using a paired *t*-test for the 12 sections. There were no significant differences ($P > 0.05$) between years in either total birds seen or numbers of ponds occupied.

Horned Grebes were never seen on Type 1 ponds. In 1974, they were recorded on four Type 3 ponds during counts, and in 1975, on one. The first year, 30% were seen on Type 4 ponds compared with 68% on Type 5 ponds. The 1975 figures were 22% and 77% for Types 4 and 5 ponds, respectively. In both years these propor-

TABLE 1—Comparison of numbers of ponds occupied by various numbers of Horned Grebes on a 31.1-km² area during 1974 and 1975 counts

Number of birds	Number of ponds					
	Date in May 1974			Date in May 1975		
	17	23	24	8	12	15
1	18	24	24	14	11	15
2	51	44	34	17	29	39
3	0	1	0	0	1	1
4	3	0	1	0	0	0
5	0	0	0	1	0	0
6	0	0	1	0	0	0
Total number						
Ponds with						
birds	72	69	60	32	41	55
Birds	132	115	102	53	72	96

tions were significantly different ($P < 0.001$) from those expected if distribution had been proportional to the numbers of Types 4 and 5 ponds present. The grebes showed a strong preference for the permanent Type 5 ponds that contained patches of open water. Faaborg (1976) also found that Horned Grebes tended to select open ponds, but permanency type seemed unimportant in that study. The preference for Types 4 and 5 ponds was reflected in the grebe distribution on the study area. Numbers of birds on individual 259-ha sections were directly correlated with numbers of Types 4 and 5 ponds in both years ($r = 0.8$; $P < 0.001$).

Size of ponds also influenced the distribution of Horned Grebes, with higher use shown for large ponds. This tendency likely accounted for part of the disproportionate use of Types 4 and 5 ponds because the average area of the latter was greater. In 1974, the distribution was significantly non-random ($P < 0.001$) with regard to size on both Type 4 and Type 5 ponds. Most of the difference was due to the low use of ponds under 0.2 ha and, conversely, high use of ponds over 0.4 ha. Use of Type 5 ponds in 1975 was likewise related to size ($P < 0.001$), but the small sample for Type 4 ponds did not reveal any significant difference ($P > 0.05$) with regard to size.

The presence or absence of tree growth around ponds had no significant ($P > 0.05$) effect on the use of ponds by Horned Grebes in either year. They used all categories of ponds including those completely closed and less than 0.2 ha. Dwyer (1970) compared numbers of Horned Grebes on two Manitoba areas of equal size, one in a park with tree growth around all ponds and one 8 km from the first but on agricultural land where ponds were largely devoid of trees. Considerably more pairs were seen on the agricultural area and Dwyer (1970) concluded that tree growth around the ponds in the park deterred the birds. My results indicate that other factors probably were responsible for the observed differences in Horned Grebe numbers between the two Manitoba areas.

In both years, Horned Grebes tended to use ponds surrounded by pasture in preference to those surrounded by cultivated land. Tests showed significance ($P < 0.05$) for all three counts in 1974, and the last two in 1975

($P < 0.02$ and $P < 0.01$). Reasons for selection of pasture ponds are unknown, but may have involved an innate preference for a relatively pristine landscape, differences in food resources between the ponds, or disturbance by farming activities on cultivated land.

Nesting Chronology

Based on a laying rate of an egg every 2 days (DuBois 1919), and in some cases, size of young, most of the clutches in both years had been started in late May or early June. In 1974 at least 16 nests had been started in May and 38 in 1975. Perhaps the earliest were two nests, each with eight eggs in early incubation, found on 30 and 31 May. Four nests in 1974 and 18 in 1975 had been started in late June or early July, considerably later than average. These may have been re-nesting attempts because Horned Grebes readily re-nest if their first nest is destroyed (DuBois 1919; Fjelds  1973b). My data on nesting chronology contrast with those of Munro (1941) for a similar latitude in British Columbia, where it was unusual for eggs to be laid before the last week of June or early July. Egg dates given by Bent (1963), however, indicate that the Horned Grebes on my area did not nest unusually early.

Distribution of Nests

In 1974, 47 Horned Grebe nests or broods were found on the study area for a density of 1.5 km². All were on different ponds. There were 103 or 3.3 per km² in 1975. Reasons for the difference in nesting effort between the two years (see figures for adults in Table 1) are unknown. Evidently there were considerable numbers of non-breeding birds in the 1974 population, whereas most of the birds observed in 1975 were breeders. Munro (1941) stated that it was usual to find small numbers of non-breeding Horned Grebes on his British Columbia area. Fjelds  (1973b) reported that 9 to 10% of the birds did not breed in Iceland and Norway. There, the rate of non-breeding decreased with increasing lake productivity (standing crop of benthos). Also, non-breeding birds apparently were mostly first-year birds unable to compete successfully for suitable territories.

Nests were not found on Types 1 and 3 ponds (Table 2). Obviously, the temporary nature of these ponds in most years would create a lethal

TABLE 2—Numbers of Horned Grebe nests in relation to pond size and permanency type (1974–1975)

Pond size (ha)	Numbers of nests ¹ and ponds ¹ in each permanency type								Nests per pond ²
	Type 1		Type 3		Type 4		Type 5		
	nests	ponds	nests	ponds	nests	ponds	nests	ponds	
< 0.21	0	196	0	326	7	227	3	41	0.04
0.21–0.40	0	13	0	64	8	118	21	81	0.15
0.41–0.81	0	2	0	29	16	114	30	94	0.22
0.82–1.62	0	0	0	8	8	55	31	96	0.26
1.63–3.24	0	0	0	1	2	11	16	49	0.30
> 3.24	0	0	0	0	1	4	7	18	0.36
Totals	0	211	0	428	42	529	108	379	0.17

¹Figures for 1974 and 1975 pooled.²Average for pooled Types 4 and 5 ponds.

brood trap for grebes that nested on them. In 1974, 13% of nests occurred on Type 4 ponds and 87% on Type 5 ponds. Figures for 1975 were 35% and 65% for Types 4 and 5 ponds, respectively. In both years there was unexpected high use ($P < 0.001$) of Type 5 ponds based on proportions of those present. As with birds observed during counts, the distribution of nests among the 12 sections was correlated with numbers of Types 4 and 5 ponds ($r = 0.8$; $P < 0.002$).

Pond occupancy rate by nesting Horned Grebes increased with pond size (Table 2). It was comparatively low for ponds up to 0.2 ha and increased gradually for larger ponds. The relationship was strongest for Type 4 ponds. The probability of a Type 4 pond having patches of open water increased with size, and I believe this influenced selection by grebes. All Type 5 ponds had some open water; size would be less important in these.

One pond had more than one nest. This was a 7.8-ha, Type 5 pond with two nests. Munro's (1941) observations in British Columbia suggested that two or more nesting pairs on one pond were more common there. He observed three pairs on a 2-ha pond in two successive years and five nests one year on a 30-ha lake. In western Saskatchewan, Renaud and Renaud (1975) reported four breeding pairs on a 8.1-ha pond. Stewart (1975) stated that Horned Grebes in North Dakota usually nested as solitary pairs on the smaller ponds or as widely scattered pairs on the larger lakes. An exception was five nests on a 17.4-ha pond. Fjelds  (1973b) found that coexistence (two or more pairs) seldom occurred

on "unfertile" ponds under 5 ha in Iceland. In contrast, it was relatively common on "fertile" ponds over 1 ha. He showed that, on the average, grebe pairs had exclusive use of areas many times larger than that needed for successful breeding, and suggested that territorial behavior brought about an overdispersal of pairs. This also seemed to be the case on my area and the comparatively high density of suitable ponds allowed pairs to nest solitarily.

The presence or absence of tree growth around ponds had no apparent effect on the choice of ponds by nesting Horned Grebes. Ratios of treed ponds selected to those present did not differ significantly in 1974 ($P > 0.05$) or in 1975 ($P > 0.5$).

From data based on nest distribution, nesting Horned Grebes did not show a preference for pasture ponds as did birds in the pre-nesting population either in 1974 ($P > 0.8$) or in 1975 ($P > 0.1$). The tendency for nesting pairs to disperse may be stronger than their attraction to ponds in uncultivated areas.

Nest Sites

The sites of 92 nests were recorded in 1975; 40% of the nests were supported by flooded willows (*Salix* spp.) and 10% by dead cattail (*Typha latifolia*). The others, 50%, were floating or loosely anchored structures in open sites, sometimes surrounded by new growth of whitetop (*Scolochloa festuacea*) or, less commonly, sedge (*Carex atherodes*) later in the season. Water depth at 50 nests in 1975 averaged 86 cm (range, 25 to 140 cm). This is a

conservative estimate because a few were not recorded as they were too deep to reach by wading and were not visited with a canoe. Depth at 11 nests measured by Stewart (1975) in North Dakota averaged 41 cm (range, 15 to 122 cm). The comparatively high average depth for my sample probably reflects the relatively high water levels in the ponds that year.

Conclusions

Throughout the breeding season, Horned Grebes used the more permanent ponds almost exclusively. Ponds over 0.2 ha were also favored, probably because they contained more open water. No other habitat factor appeared to affect the distribution of nesting grebes.

Land use practices such as drainage and filling tend to affect adversely temporary wetlands at a higher rate than permanent wetlands (Kiel et al. 1972). Thus, compared with many bird species associated with wetlands, the Horned Grebe enjoys a relatively secure habitat. Although a few small temporary ponds on the study block had been destroyed, there was no evidence that any of the permanent ponds had been altered significantly. This small area, however, cannot be considered representative of the Canadian parklands. Elsewhere, wetlands, including permanent ponds, are being destroyed at a higher rate (Kiel et al. 1972).

Little is known about the effects of agricultural chemicals on these pothole ecosystems. These also need investigation because, in the long term, they may be just as damaging as physical alteration.

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The Structure and Rate of Growth of the Rhizomes of Some Forest Herbs and Dwarf Shrubs of the New Brunswick – Nova Scotia Border Region

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Sobey, Douglas G. and Peter Barkhouse. 1977. The structure and rate of growth of the rhizomes of some forest herbs and dwarf shrubs of the New Brunswick – Nova Scotia border region. *Canadian Field-Naturalist* 91(4): 377–383.

Rhizome growth was examined in 41 herbs and dwarf shrubs of hardwood and mixed forests in the New Brunswick – Nova Scotia border region of Canada. For each species the morphology of rhizome growth was examined and the rate of growth (cm/yr) was estimated.

Thirty-four of the species had either surface or underground rhizomes and in 32 of these ramification or division of plants was observed. Two of the species that lacked rhizomes were able to spread by means of horizontal roots on which adventitious buds developed. The maximum rates of rhizome or root growth varied from almost nil for some species to rates approaching 1 m/yr for others. The frequency of branching also varied although this was not precisely determined for many species. Examination of the results indicates that most of the species of slower rhizome growth are characteristic of the climatic climax fern-herb forests of the region, whereas many of the species of faster rhizome growth are more characteristic of the successional stages after fire, logging, or other disturbances. The adaptive significance of these findings is discussed.

Key Words: rhizome structure, rhizome growth, vegetative spread, forest herbs, maritime provinces.

Vegetative reproduction by means of the growth and branching of horizontal rhizomes has long been recognized as an important method of plant propagation, but comparatively little is known about such reproduction in natural habitats. Several European workers have investigated different aspects of vegetative propagation in meadow and forest species (Oinonen 1967a, b, 1968, 1971; Harberd 1961, 1963; Tamm 1972a, b). North American studies include those of Holm (1925), Whitford (1949, 1951), Struik (1965) and Bell (1976).

Some of the above studies included estimates of the rates of rhizome growth of particular species but none attempted to examine and compare the rates in a large number of species from the same type of habitat. This was the purpose of the work reported here which was carried out near Sackville, New Brunswick in the summer of 1969. It was intended to examine rhizome growth among the plants comprising the ground flora of local forests. Forty-one of the 53 species considered eligible were examined and for each of these an attempt was made to determine the morphology of rhizome growth and the rate of such growth in centimetres per year, including where possible the extent of branching.

Since the study was intended as a broad survey in a field that has been largely unexplored, there are gaps in the data and most of the species would benefit from more detailed separate investigations. It should also be noted that only a few specimens of each plant species were examined, and though they are considered typical of the habitat in which they are found, they are not necessarily representative of the species throughout its range or in all types of habitat.

Methods

Thirty-two of the species were examined in a forest along the Upper Walker Road, about 4.5 km from Sackville, Westmorland County, New Brunswick. The site contained extensive stretches of young hardwood trees and has a long history of selective logging. Sugar maple (*Acer saccharum*), beech (*Fagus grandifolia*), and yellow birch (*Betula alleghaniensis*) were the principal tree species with occasional red maple (*Acer rubrum*), paper birch (*Betula papyrifera*), red spruce (*Picea rubens*), and balsam fir (*Abies balsamea*), the latter two occurring as dominants in some areas. The soil was a podzol with a loose well-humified litter layer.

Eight species (*Polystichum acrostichoides*,

Athyrium filix-femina, *Streptopus roseus*, *Polygonatum pubescens*, *Medeola virginiana*, *Actaea pachypoda*, *Mitchella repens*, and *Prenanthes altissima*) were collected from a mature hardwood forest near Fenwick, Cumberland County, Nova Scotia. At this site occasional hemlock (*Tsuga canadensis*) occurred, along with the dominants sugar maple, beech, and yellow birch. The soil at this site was also a podzol. One species, *Pyrola elliptica*, was collected along a roadside near Sackville.

Each species was first examined *in situ*. Specimens were then dug up with the underground parts of some species being mapped. Further measurement and examination of the specimens took place in the laboratory. Though the rate of rhizome growth was determined accurately for some species, for others it was only estimated and for some it could not be determined during the time of the study.

The methods used to assess the rate of growth of horizontal rhizomes or stolons were the following:

(1) Species with persistent (i.e., wintergreen) leaves along their rhizomes frequently had features which distinguished one year's increment from another. All six clubmosses had clusters of either shorter leaves or scales on their aerial shoots and/or on their horizontal above-ground rhizomes marking the division between two year's growth (Figure 1). The amount of growth of *Lycopodium lucidulum*, *L. clavatum*, *L. annotinum*, *L. obscurum*, and *L. flabelliforme* was thus measured exactly for several years back, and that of *L. tristachyum* was estimated. In *L. lucidulum* the persistent sporangial cases of recent years corroborated the above leaf evidence.

In other species with persistent leaves along horizontal stems (*Linnaea borealis*, *Mitchella repens*, *Gaultheria hispida*) slight differences in the color and size of leaves and the color and shape of stems were used to distinguish the current year's growth from that of previous years (Figure 1). Thus a fairly accurate measure of the amount of new growth and sometimes that of preceding years was obtained.

(2) The remains of old shoot or leaf bases along a rhizome or of scars marking the position of old shoots were used to estimate the rate of growth of many plants including the ferns, the stipe bases of which persist for many years (Figure 1). By counting the number of dead stipe bases along a rhizome and counting the number of fronds produced per year at shoot points on living plants, the rate of horizontal growth was estimated for the following species:

Osmunda claytoniana, *Polystichum acrostichoides*, *Dryopteris spinulosa*, *D. phegopteris*, *Athyrium filix-femina*, and *Pteritis pensylvanica*. The presence of scars or shoot remnants were also used to estimate the growth rate of *Smilacina racemosa* (Figure 1), *Streptopus roseus*, *Polygonatum pubescens*, *Clin-tonia borealis*, *Aster acuminatus* (Figure 1), *Anaphalis margaritacea*, *Trillium erectum* (Figure 1), *Trillium undulatum* (Figure 1), and *Galium triflorum*.

Sometimes shoot points continue to produce a shoot for several years while new shoot points are continually added at the anterior growing end of a rhizome. The distance between such shoots was assumed to equal the annual increment and, along with supporting information (see below), was used to estimate the growth rates of *Aralia nudicaulis* and *Maianthemum canadense*.

(3) In *Medeola virginiana* and *Trientalis borealis* (Figure 1), the position of the following year's shoot was marked by a tuber which developed at the end of a rhizome in late summer. The distance between the current year's shoot and this tuber represents the annual rhizome growth. Determined in somewhat the same way was *Pteridium aquilinum* in which future year's fronds were present in various stages of development, the evidence suggesting that the distance between the incipient fronds represents an annual increment.

(4) For some species (*Cornus canadensis*, *Gaultheria procumbens*, *Coptis trifolia*, *Oxalis montana*, and *Maianthemum canadense*) the rhizome produced in the current year was often lighter in color than that produced during previous years, and this was used to estimate the growth rate where there was no other evidence.

(5) Internodal lengths on the horizontal rhizome (i.e., the distance between scales or leaves) aided with *Aralia nudicaulis* and *Maianthemum canadense*. Shorter internodes were presumed to mark the cooler days of fall and thus the point of division between two years' growth.

No estimate was obtained for the rate of growth of *Pyrola elliptica*, *Epilobium angustifolium* and *Aralia hispida*, the last two of which spread vegetatively by the horizontal growth of roots (confirmed by microscopic examination of cross-sections).

Results

Morphology of Rhizome Growth

Of the 41 species examined, 34 had either surface or underground rhizomes (the seven not possessing rhizomes were *Prenanthes trifoliolata*, *P. altissima*, *Actaea pachypoda*, *Monotropa uniflora*, *Cypripedium acaule* and the two species spreading by the horizontal growth of

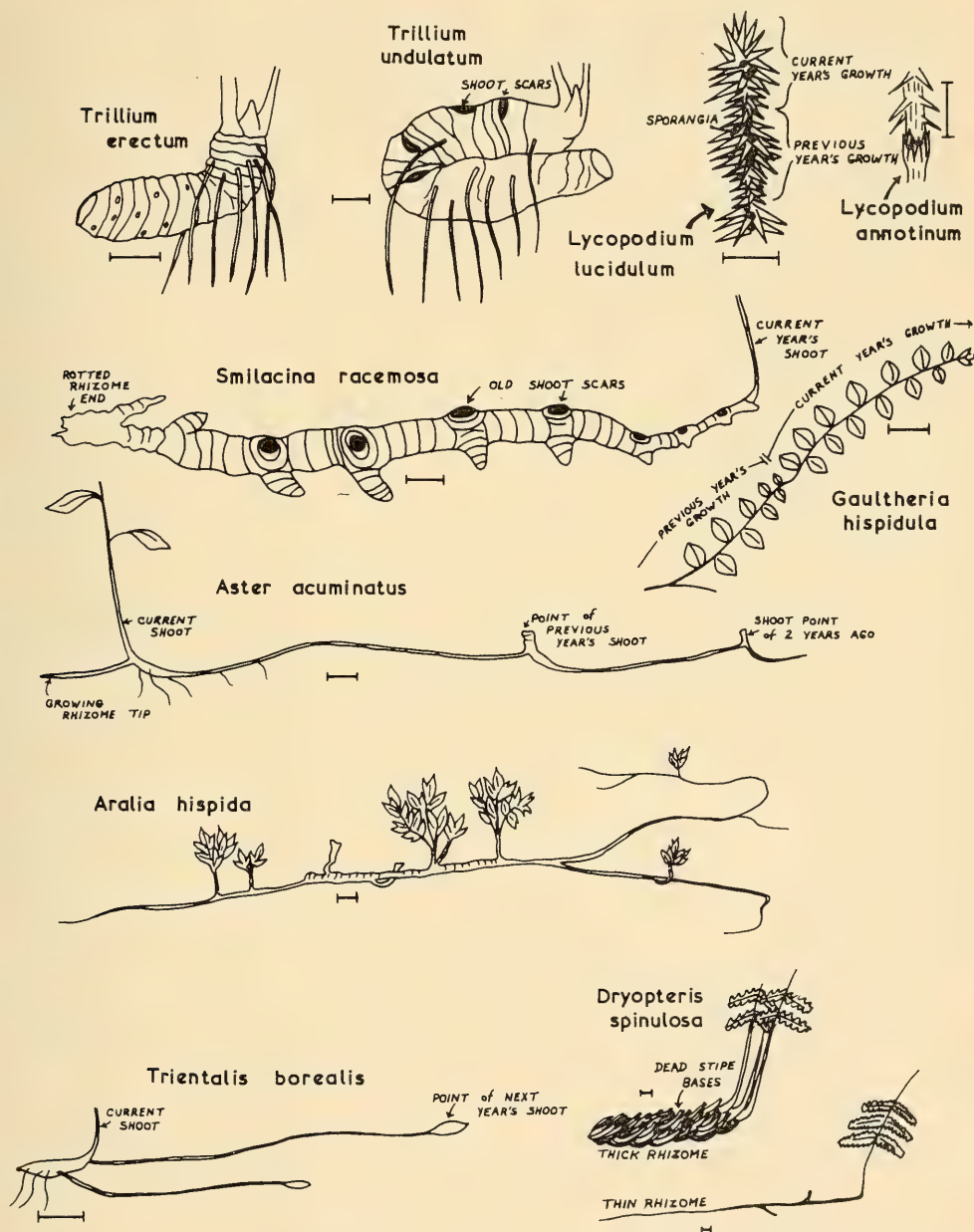


FIGURE 1. Structures associated with vegetative spread in some of the species examined. All are rhizomes or surface stems except the underground parts of *Aralia hispida* which are roots. For *Lycopodium annotinum* a cluster of short scale-leaves marking the division between two years' growth is shown. Bar scale for each figure is 1 cm.

roots — *Epilobium angustifolium* and *Aralia hispida*). In 32 of these 34, vegetative spread (i.e., ramification or division of plants) was observed (Table 1); the two not showing clear-cut ramification were *Trillium erectum* and *T. undulatum*.

In those species spreading by means of the growth and branching of a horizontal rhizome, the older posterior parts of the rhizome gradually die and decay, leading to the fragmentation of the original plant. In some species (*Lycopodium lucidulum*, *L. annotinum*, *L. clavatum*, *Gaultheria hispida*, *Galium triflorum*, *Mitchella repens*, *Linnaea borealis*) the rhizome (or stolon) initially developed as a prostrate stem on the soil surface which usually became covered with surface litter after the first year. In the remaining species the rhizome developed below the surface, generally in the upper few centimetres of the humus layer, though in *Pteridium aquilinum* it was deep (about 15 cm) in the eluviated horizon of the mineral soil.

The shape and form of the rhizome and the morphology of branching showed some variation but a detailed examination of this aspect was beyond the scope of this study. In general the rhizomes were of two types: some were long and slender with the nodes (marked by fine scales or leaves) at least several centimetres apart (e.g., Figure 1, *Aster acuminatus*); others were short and stout, with the nodes, and frequently the points of origin of shoots, bunched together (e.g., Figure 1, *Smilacina racemosa*). In three species (*Dryopteris spinulosa* (Figure 1), *Pteris pensylvanica*, *Streptopus roseus*), both slender and stout rhizomes were noted.

In two of the species (*Medeola virginiana* and *Trientalis borealis*) a special form of rhizome growth was noted (Figure 1). Both slender rhizomes and aerial shoots develop in the early part of the growing season from a tuber. In late summer horizontal growth of the rhizome(s) ceases and a new tuber develops at the tip of each rhizome. The old tuber and rhizome decay over winter and the following season's shoot develops from the new tuber.

Though the *Trillium* species were not observed to spread vegetatively, they did have underground rhizomes about 10 cm deep in the mineral soil (Figure 1). These had very short

internodes and were tuber-like. Tiny tuber-like structures without shoots attached were found adjacent to larger shoot-producing *T. erectum* rhizomes. They appeared to have originated from the larger rhizome though no connection was observed.

Rate of Horizontal Growth of Rhizomes, Stolons, and Roots

The rate of rhizome growth varied from almost nil for some species to rates approaching 1 m per year for others (Table 1). There was variation among plants of the same species and also from year to year for the same plant. A plotting of the estimated maximum rates of rhizome growth (Figure 2) permits comparison between species. The frequency of branching of the horizontal rhizomes or roots also showed wide variation (Table 1), but for many species it could not be precisely determined from a single season's work.

Discussion

The rates of rhizome growth in Table 1 are generally similar to values obtained for the same species in other studies. Whitford (1951) recorded a growth rate of 0.73 in/yr (1.9 cm) for *Athyrium filix-femina* rhizomes (slightly in excess of that recorded in this study), and 0.94 in/yr (2.4 cm) for *Smilacina racemosa* (which falls within the range of 1–3 cm in Table 1). Anderson and Loucks (1973) in a detailed study of *Trientalis borealis* examined 93 plants and recorded rhizome lengths ranging from 5 cm to greater than 1 m with an average of about 30 cm; in this study lengths of up to 80 cm were recorded. Oinonen (1967a) estimated an annual radial increase of 17.9 cm for *Pteridium aquilinum* clones in Finland, which falls within the 15- to 30-cm range observed in this study, and 15.1 cm/yr for *Lycopodium complanatum* (Oinonen 1967b); the values for *L. flabelliforme* (which Fernald (1950) considers to be a variety of *L. complanatum*) were 17–31 cm. He also recorded (Oinonen 1968) a range of 3 to 86 cm in the annual growth of shoots of *L. clavatum* (8–74 cm were observed in this study), and 2–58 cm for *L. annotinum* (5–45 cm were recorded in this study). In Massachusetts Primack (1973) recorded the following ranges in the rhizome growth of five *Lycopodium* species: *L.*

TABLE 1—Data on vegetative spread for the 41 forest herbs and dwarf shrubs examined

Species	Vegetative spread (i.e. ramification observed)	Observed range in growth rate or max. growth rate of horizontal rhizomes, roots or stolons (cm/yr)	Frequency of rhizome branching
<i>Lycopodium lucidulum</i>	+	1-3	Irregular—1 branch/3-12 or more years
<i>L. annotinum</i>	+	5-45	Frequent (ca. 1/yr)
<i>L. clavatum</i>	+	8-74	1 branch/3-4 yr
<i>L. obscurum</i>	+	13-20	1 branch/yr
<i>L. flabelliforme</i>	+	17-31	Irregular but frequent (ca. 1 branch/yr)
<i>L. tristachyum</i>	+	ca. 15 (max.)	Not determined
<i>Osmunda claytoniana</i>	+	< 1/2 (max.)	1 branch/75 yrs
<i>Pteritis pensylvanica</i> ^a	+	<1 (max.)	Not determined
<i>Dryopteris phegopteris</i>	+	1 1/2-3	1 branch/6-11 yrs
<i>D. spinulosa</i> ^a	+	<1; <4 (max.)	Not determined
<i>Polystichum acrostichoides</i>	+	<1 (max.)	Not determined (but infrequent)
<i>Athyrium filix-femina</i>	+	<1 (max.)	Not determined (but infrequent)
<i>Pteridium aquilinum</i>	+	15-30	1 branch/yr
<i>Clintonia borealis</i>	+	6-10	1 branch/4-10 yrs
<i>Smilacina racemosa</i> ^b	+?	1-3	None observed
<i>Maianthemum canadense</i>	+	ca. 15-30	Not determined (appears frequent 1 branch/1-3 yr?)
<i>Streptopus roseus</i> ^a	+	<1; 4 1/2 (max.)	Not determined
<i>Polygonatum pubescens</i> ^b	+?	1-3	None observed
<i>Medeola virginiana</i> ^b	+?	2-8	None observed
<i>Trillium erectum</i> ^c	?	0.4-0.6	None observed
<i>T. undulatum</i>	None observed	0.4-0.5	None observed
<i>Cypripedium acaule</i>	None observed	Nil	None observed
<i>Coptis trifolia</i>	+	5-(15?)	Not determined (appears frequent 1 branch/yr?)
<i>Actaea pachypoda</i>	None observed	Nil	None observed
<i>Oxalis montana</i>	+	10 (max.)	Not determined
<i>Epilobium angustifolium</i>	+	Not determined	Not determined but appears frequent
<i>Aralia hispida</i>	+	Not determined	Not determined
<i>A. nudicaulis</i>	+	25-80	Potentially 1 branch/yr but much less—1 branch/4-5 yr(?)
<i>Cornus canadensis</i>	+	>18 (max.)?	Appears frequent
<i>Monotropa uniflora</i>	None observed	Nil	None observed
<i>Pyrola elliptica</i>	+	Not determined	Not determined
<i>Gaultheria procumbens</i>	+	>10 (max.)?	Not determined, irregular
<i>G. hispida</i>	+	2-7	Not determined, but frequent
<i>Trientalis borealis</i>	+	80 (max.)	Not determined
<i>Galium triflorum</i>	+	<5 (max.)	Not determined
<i>Mitchella repens</i>	+	<10 (max.)	Irregular but frequent (1 branch/yr?)
<i>Linnaea borealis</i>	+	11-48	(1 branch/3-4 yr?)
<i>Aster acuminatus</i>	+	1-25	Not determined
<i>Anaphalis margaritacea</i>	+	2-20	Not determined but frequent
<i>Prenanthes trifoliolata</i>	None observed	Nil	None observed
<i>P. altissima</i>	None observed	Nil	None observed

^a *Pteritis pensylvanica*, *Streptopus roseus*, and *Dryopteris spinulosa* (see Figure 1) had both thick and thin rhizomes. For *Pteritis* the growth rate of only the thick rhizome was determined; for *Dryopteris* and *Streptopus* both rates were determined and that of the thick is listed first.

^b Actual ramification was not observed in *Polygonatum pubescens*, *Medeola virginiana*, and *Smilacina racemosa* but the presence of lateral buds on the rhizomes suggest a capacity for such ramification.

^c Special tuber-like structures were observed near *Trillium erectum* rhizomes (see main text).



FIGURE 2. The estimated or observed maximum annual rates of horizontal rhizome growth for 33 of the 41 species examined. Of the remaining eight species, horizontal growth was not observed in five (*Cypripedium acaule*, *Monotropa uniflora*, *Actaea pachypoda*, *Prenanthes altissima*, and *P. trifoliolata*) and no estimate was obtained for *Pyrola elliptica* and the two species spreading by horizontal roots (*Epilobium angustifolium* and *Aralia hispida*) both of which appear to spread rapidly.

flabelliforme (26–50 cm/yr), *L. clavatum* (48–103), *L. annotinum* (22–45), *L. obscurum* (13–21), *L. lucidulum* (1.5–2.2) — all of which, to varying degrees, overlap the ranges recorded in Table 1.

The wide range observed among the species in the rates of rhizome growth and branching is not surprising in view of the taxonomically diverse group of plants examined. Among particular taxa there is some consistency: the clubmosses, with one exception, are among the species with faster growing rhizomes (all have maximum rates of rhizome growth greater than 15 cm/yr). The exception, *L. lucidulum*, has a maximum rate of only 3 cm. In contrast the ferns (like the clubmosses, spore-producing plants) with the exception of *Pteridium aquilinum*, are plants of slow rhizome growth, mostly under 1 cm/yr. *Pteridium* by contrast has a maximum rate of 30 cm.

It is more informative to group the plants according to the community in which they occur rather than according to taxonomics. Many of the plants of slower or no rhizome growth

(*Lycopodium lucidulum*, *Dryopteris phegopteris*, *D. spinulosa*, *Polystichum acrostichoides*, *Athyrium filix-femina*, *Smilacina racemosa*, *Streptopus roseus*, *Medeola virginiana*, *Clintonia borealis*, *Oxalis montana*, *Monotropa uniflora*, *Mitchella repens*, *Trillium undulatum*, *T. erectum*) are characteristic of the sugar maple-beech-hemlock fern-herb forest which is considered to be the climatic climax forest on the better soils in New Brunswick – Nova Scotia. In such a supposedly stable climax habitat plants theoretically have an unlimited time in which to colonize the habitat and this may be the reason why many species have not evolved a more rapid rate of rhizome spread.

By contrast, many of the species of more rapid rhizome growth (*Lycopodium annotinum*, *L. clavatum*, *L. obscurum*, *L. flabelliforme*, *L. tristachyum*, *Cornus canadensis*, *Linnaea borealis*, *Pteridium aquilinum*, *Anaphalis margaritacea*, and *Aster acuminatus* (plus *Epilobium angustifolium* and *Aralia hispida* whose rates of spread were undetermined but would appear to be rapid) are species more characteristic of the

early to late successional stages after fire, logging, or other disturbances. In such successional communities where environmental conditions are slowly but continually changing there is a limit to the time that a seral species will find favorable conditions enabling it to occupy a site. Under such circumstances rapid rhizome growth and spread may have evolved as an adaptive advantage permitting extensive colonization before conditions became unfavorable. More precise estimates may even reveal a gradation in the rate of rhizome growth among the early to late successional herbs. The taxonomic anomaly mentioned above is now seen to be explained by the ecological status of the species. The only slow-growing clubmoss, *L. lucidulum*, is also the only clubmoss characteristic of the climax forest; *Pteridium*, the fast-spreading fern, is the only fern examined characteristic of the early successional stages.

This study has been a rather broad survey of rhizome growth among a group of plants from the same habitat. Our understanding of most of the species might benefit from more detailed examination. Also other species and other habitats deserve investigation. It may well be found that the difference in the rates of rhizome growth between species of seral and climax communities suggested by this study is a feature not only of forests, but also of other communities.

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New Vascular Plant Records on Pelee and East Sister Islands, Essex County, Ontario

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Pelee Island, the southernmost part of Canada, has a diverse and very interesting flora containing many species rare or absent elsewhere in Canada. Reported as new to Canada are seven species of vascular plants: *Carex davisii*, *Carex divulsa* subsp. *leersii*, *Sedum telephioides*, *Euphorbia obtusata*, *Myosotis macrosperma*, *Lycopus virginicus* var. *virginicus*, and *Senecio glabellus*. These are briefly discussed. In addition, we report on the status of 13 very rare species known previously from the area: *Camassia scilloides*, *Spiranthes magnicamporum*, *Celtis tenuifolia*, *Chenopodium foggii*, *Thalictrum dasycarpum*, *Corydalis flavula*, *Cydonia oblonga*, *Ammannia coccinea*, *Chaerophyllum procumbens*, *Phacelia purshii*, *Conoclea multifida*, *Eupatorium altissimum*, and *Eclipta prostrata*. Fifty-five other species that are additions to the published flora of the Erie Archipelago, Pelee Island, and East Sister Island are listed as well.

Key Words: vascular plants, floristics, Erie Archipelago, Ontario, Canada, endangered species, phytogeography.

Field work on Pelee Island, Essex County, Ontario, during the past 10 years has resulted in a number of discoveries of considerable floristic interest. Several species not previously reported for Ontario or even for Canada have been recorded, although the Erie Islands have been quite extensively botanized (Macoun 1893; Core 1948; Duncan 1973).

The first botanist to collect extensively on Pelee Island was John Macoun, Canadian Dominion Botanist, in 1882 (Macoun 1893). Later came C. K. Dodge, who produced the first list of Pelee Island plants (1914), and then Core (1948). The collections of Wilfred Botham, of Cottam, Ontario were largely the basis for Boivin's (1953) additions to Core's list. Recent work by Stuckey (1968), Duncan and Stuckey (1970), and Duncan (1973), as well as by Stuckey and Duncan, currently updating the work of Core, has added considerably to the published flora. Our paper reports species in addition to those recorded in these lists.

Pelee Island in particular has a wide diversity of plant habitats and a large flora for such a small area. The island is situated in the western end of Lake Erie, in extreme southern Canada between 41°43' to 41°50'N, and 82°37' to 82°42'W. It is the largest of the Erie archipelago islands: 4083 h (10085 acres). East Sister Island, also part of Pelee Township, is approximately 13 km (8 mi) west of Pelee Island, at 41°49' N, 82°50' W; it is some 26 h (65 acres) in size, of which only about 14.6 (36) have been above water recently.

The warm climate of Pelee Island is largely a result of the moderating effects of Lake Erie; the mean annual temperature is 9.6°C (49.3°F), several degrees higher than that of the mainland of Essex-Kent Counties. The average growing season (free of killing frosts) is 192 days. Droughty conditions do occur as a result of lighter rainfall than on the mainland (Core 1948). Pelee Island has relatively low rainfall, slightly under 75 cm (30 in) per year.

The flora of Pelee Island has strong affinities with the Ohio-Mississippi River lowlands, and this affinity is reflected by some of the most abundant trees on the island, e.g., *Celtis occidentalis*, *Acer nigrum*, *Fraxinus quadrangulata*, *Quercus macrocarpa*, and *Populus deltoides*. The north shore of Ohio was mapped as having small prairie outliers by Transeau (1935); prairie species are fairly well represented on Pelee Island. Also, owing to its floristic affinities with the mid-west, Pelee Island, and especially the southern points of it (Figure 1) are much more similar to Point Pelee than to the Niagara Peninsula, despite the limestone bedrock. Few elements of the eastern Carolinian and/or Appalachian flora occur on Pelee Island; the Tulip-tree (*Liriodendron tulipifera*) and *Magnolia acuminata*, for example, are missing from the Erie Islands. The flora of these islands is of continual interest because of the southern species which seem to shift northward and thus first reach Canada on this archipelago.

Because of the warm climate of Pelee Island,

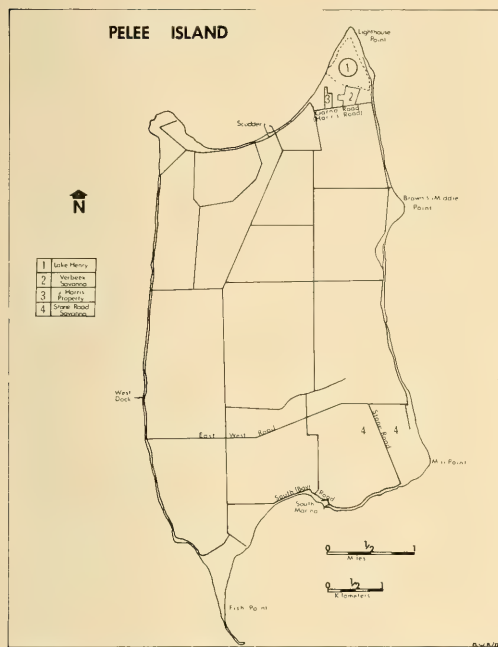


FIGURE 1. Map of Pelee Island showing major collecting locations.

several cultivated species which persist and slowly spread on Pelee Island do so rarely or not elsewhere in Canada. These have not been discussed in the list. They include *Rosa multiflora*, *Lonicera japonica*, and *Prunus persica*.

The flora of Pelee Island is also somewhat paralleled by the fauna. The Small-mouthed Salamander (*Ambystoma texanum*), the Blue Racer (*Colester constrictor foxi*), the Red-bellied Woodpecker (*Melanerpes carolinus*), and Blanchard's Cricket Frog (*Acris crepitans blanchardi*) occur in Canada as well established populations on Pelee Island only. These species are widespread in the central Mississippi-Ohio lowlands, but very rare or absent elsewhere north of the international boundary.

Our floristic additions are recorded in the form of an annotated list, dealing first with vascular plants new to Canada, and second with recent observations of rare species. A short discussion of the floristic and phytogeographic significance of each species is provided. A table summarizing other additions to the flora of Pelee

and East Sister Islands and including whether the species are new to the flora of the Erie Archipelago is also included.

Our major collecting sites are shown in Figure 1; others are specified in the annotated list which follows. Habitats are briefly noted; more details in connection with the present paper can be obtained from the Canadian Botanical Association's Survey of the Rare and Endangered Plants of Canada.

Annotated List of Species

New to Canada

Carex davisii Schwein. & Torr.

Essex County, 9.6 km (6 mi) northeast of Amherstburg along Canard River, occasional at edge of deciduous woods, 24 June 1955, *Calder and van Rens* 15928 (DAO,TRT) (sub *C. formosa*).

Pelee Island, Mill Point, south side of main E-W road, edge of woods and cultivated field, 28 June 1975, *Campbell and Harris* (TRTE, WLU).

This southern and mid-western species of lowland woods and meadows was previously recorded from nearby South Bass and Kelley's Islands, Ohio (Core 1948) and sparingly from extreme southern Michigan (Voss 1972). The report of this species from Quebec (Marie-Victorin 1935) has been shown to be an error by Rouleau (1964).

Carex divulsa Stokes subsp. *leersii* (Aschers & Graebn.) W. Koch

(*C. polyphylla* Kar. + Kir., *C. leersiana* Rauschert, *C. leersii* F. W. Schultz). Along South Road at junction with Stone Road just west of Mill Point, Pelee Island, 8 August 1974, *Reznicek, Campbell and Donaldson* (TRTE).

A Eurasian sedge, *C. divulsa* subsp. *leersii* prefers calcareous soil (Jermy and Tutin 1968), as is the case on Pelee Island. The taxonomic status of the *Carex muricata* aggregate, to which this species belongs, is not yet fully clear. We follow here the nomenclature proposed by David and Chater (1977). Further discussion of this difficult complex of species is provided by Jermy and Tutin (1968), David and Kelcey (1974), and David (1976). Complete synonymy is listed in David (1976).

Sedum telephioides Michx.

Pelee Island, Verbeek savanna, dry limestone outcrop, pasture, 4 September 1974, *Campbell and Donaldson* (WLU).

This species was growing with *Corydalis flavula* in open rocky savanna. Since it was observed growing here close to houses, it may well be an escape from cultivation. It was not reported for the Erie Islands by Core (1948) and Boivin (1953). Its native range is to

the south of Lake Erie (Clausen 1975), and it has not been previously reported from Canada.

Euphorbia obtusata Pursh

Essex County, River Canard, 17 June 1972, *W. Botham* (in herb. *W. Botham*).

Pelee Island, Verbeek's, Harris Road (north side), open oak savanna (grazed), 9 June 1974, *Campbell and Donaldson* (CAN, WLU).

This is the first substantiated report of this species for Canada. Soper's (1949) listing of this species from southern Ontario was based on the report by Billings (1862) (J. H. Soper, personal communications 1976). Billings' report was based upon a specimen of *E. platyphylla* (Dore 1961). It is recorded by Gleason and Cronquist (1963) from Pennsylvania to Indiana.

Myosotis macrosperma Engelm. (*M. virginica* var. *macrosperma* (Engelm.) Fern.)

Pelee Island, Fish Point, woodland, 7 June 1970, *J. K. Morton* (WAT). Pelee Island, Brown's (Middle) Point, low woods, 7 June 1974, *Campbell* (CAN, WLU).

This large, wide-leaved plant of rich, low woods is quite distinct from its nearest relative in the Canadian flora, *M. verna*, which usually occurs in sunnier, drier habitats, as on Pelee Island limestone plains. *Myosotis macrosperma* is known from Ohio (Fernald 1950).

Lycopus virginicus L. var. *virginicus*

Pelee Island, Fish Point, edge of muddy field, 7 August 1974, *Campbell, Reznicek, Donaldson* (WLU); McCormick Woods, low wet woods with red ash, 7 August 1974, *Reznicek* (WLU); and Fish Point, moist sandy soil of dune slack, 7 August 1974, *Reznicek, Campbell, Donaldson* (TRTE).

Although reported for Canada in the past, previous records by many authors all appear to be based on misidentified material of *L. uniflorus*. These three collections appear to be the first authentic Canadian material to be reported. Henderson (1962) discussed the features separating these two species, and has mapped *L. virginicus* as occurring mainly south of the glaciated zone in eastern North America. Its occurrence on Pelee Island appears disjunct and similar to the distribution of *Triosteum angustifolium* (Duncan 1973), which also occurs on the island but otherwise largely south of glaciated territory. It has been recorded, however, from Green Island, Ohio (Core 1948).

Senecio glabellus Poir. Butterweed

Pelee Island, south marina, westernmost pond west of Bonnett's, moist sandy and rocky shore of Lake Erie, 8 August 1974, *Campbell, Reznicek and Donaldson* (CAN).

This annual or biennial is reported for southwestern Ohio, south-central Indiana, and southern Illinois by

Gleason and Cronquist (1963). Stuckey (1975) records it as rare and local on the American Erie Islands and, in particular, in Perry's Monument Marsh on South Bass Island, where he considered it adventive from farther south.

Recent Records of Rare Plants

Camassia scilloides (Raf.) Cory Wild Hyacinth

Pelee Island, Brown's (Middle) Point, low rich open deciduous woods, 10 May 1974, *Donaldson and Campbell P74-1* (CAN); and Fish Point, wet hedgerow, 7 August 1974, *Campbell, Reznicek and Donaldson* (WLU).

Although this lovely spring lily was known from wet meadows on White Island in the Detroit River near Amherstburg (11 June 1882, *J. Macoun*, CAN), it has been recently collected in Canada only on the Erie Islands including Hen, Middle Sister, and North Harbour (Core 1948) and Middle Island (9–10 May 1939, *H. Senn* 1128 and *J. H. Soper*, TRT). This plant is vulnerable to picking and grazing and should be protected, or its extinction in Canada is probable.

Spiranthes magnicamporum Sheviak Plains' Ladies Tresses

Pelee Island, Stone Road savanna, east side of road, dry grassy road verge, 25 September 1976, *Diebolt, Francis and Campbell* (WLU).

This mid-western species, recently described (Sheviak 1973), is known now in Ontario from a number of sites in the southwest (Catling 1976). Until this report, no *Spiranthes* were known on the Erie Islands, although Luer (1975) maps *S. magnicamporum* from the Ohio shore of Lake Erie. The Stone Road colony consisted of about 40 individuals.

Celtis tenuifolia Nutt. Dwarf Hackberry

Pelee Island, Fish Point, Lake Erie, 16 July 1958, *L. J. Stock* 348 (CAN) (sub *C. occidentalis*); and Fish Point, west side, near base of point, sand dunes, edge of Lake Erie (woods edge), 8 August 1974, *Reznicek, Donaldson and Campbell* (CAN, TRTE).

The Dwarf Hackberries of the Great Lakes region have been designated *C. tenuifolia* var. *soperi* Boivin. Boivin (1967) recorded Canadian material only for the Grand Bend area, Lake Huron, as did Wagner (1974). This plant is new for the Erie Islands flora (see Core 1948).

Chenopodium foggii Wahl

Pelee Island, Fish Point, lagoon edge, sandy woods, 4 September 1974, *Campbell and Donaldson* (WLU); Lake Henry, clay and limestone rubble dike, 18 September 1975, *Campbell, Reznicek and Donaldson PI-75-F15* (WLU, TRTE); and Verbeek's savanna, 19 September 1975, *Campbell, Reznicek and Donaldson PI-F41* (WLU).

This uncommon native southern species has also

been reported from Leeds County, Ontario and Pontiac County, Quebec (Wahl 1954) and from Lambton County, Ontario (Gaiser and Moore 1966), and no doubt occurs sparingly elsewhere in southern Ontario.

Thalictrum dasycarpum Fisch. & Lall. Purple Meadow-rue

Pelee Island, Brown's (Middle) Point, gravelly ditch, woods edge, 8 June 1974, *Campbell and Donaldson* (CAN, WLU).

Considered a northwestern species in Ontario (B. Boivin, personal communication), it is known sparingly from southern Ontario. Our collection represents an addition to the Erie Islands flora, although Core (1948) doubtfully reported it from South Bass Island, Ohio.

Corydalis flavula (Raf.) DC. Yellow Corydalis

Pelee Island, Verbeek savanna, Harris Road, rocky oak glade, 12 May 1974, *Campbell P74-26 and Donaldson* (CAN, WLU).

This delicate fumitory is presently known in Canada only from Point Pelee and Pelee Island. On Point Pelee it has been collected as recently as 1970 (17 May, *Morton*, CAN, TRT, herb. J. K. Morton). It was first collected on Pelee Island by Macoun (Burgess 1889), who also collected it at Amherstburg, Ontario, (*J. Macoun*, 10 June 1882, MTMG); and it was reported at Point Abino on the north-eastern shore of Lake Erie (Burgess 1889).

Cydonia oblonga Mill. Quince

Pelee Island, South Road (just west of south end, Stone Road), hedgerow along bush, 8 August 1974, *Reznicek, Campbell and Donaldson* (CAN, TRTE, WLU).

The only other Canadian collection outside of cultivation is from Elgin County, along a creek at Aylmer, 4 June 1953, *Montgomery and Shumovich* 606 (TRT). Our record is an addition for the Erie Islands.

Ammannia coccinea Rottb.

Essex County, Hillman Marsh, on mud flat, 42°03'N, 82°30'W, 7 September 1974, *W. Botham* 1704 (CAN); Pelee Island, Lake Henry, Lighthouse Point, mudflats, 19 September 1975, *Reznicek and Diebolt and Campbell* PI-75-F30 (DAO, WLU).

The only other Canadian collections are from Lake Osoyoos, British Columbia: *J. W. Eastham*, 27 September 1939 (DAO); *Calder and Saville* 11519, 6 August 1953 (DAO).

This is the first report of the species from eastern Canada; the collection by Campbell et al. is the first from the Erie Islands, although Core (1950) reported it from the Portage River swamps on the Ohio mainland.

Chaerophyllum procumbens (L.) Crantz Spreading Chervil

Pelee Island, Brown's Woods, 4 May 1971, *Simpson, Campbell and Pratt* (WLU); Brown's (Middle) Point, low rich deciduous woods, 11 May 1974, *Campbell P74-27 and Donaldson* (CAN); Mill Point, 12 May 1974, *Donaldson and Campbell P74-23* (WLU); Stone Road, far to the east of Stone Road, 1 June 1974, *W. Botham* 1609 (CAN); and Verbeek savanna, grassy wooded glade by south fence, 5 May 1976, *Perrin and Campbell* PI-76-11 (CAN, WLU).

This species was formerly known from Canada on White Island near Amherstburg, Ontario (moist places, 11 June 1882, *J. Macoun*, TRT), and from Kelley's Island in Ohio (Core 1948). It was collected from Pelee Island in 1914 (Point Pelee Island, 27 May 1914, *N. Tripp* (MICH)), but not from there again until our collection of 1971. As is the case in Wisconsin (Curtis 1959), on Pelee Island this plant, although very local, may occur in dense colonies of hundreds.

It is interesting that collections from Pelee Island include both *C. procumbens* var. *procumbens* and the pubescent-fruited var. *shortii*. The variety is apparently more western (Deam 1940; Fernald 1950; Gleason 1952), and Pelee Island is within the area of overlap of the two taxa.

Phacelia purshii Buckley Miami-mist

Pelee Island, Stone Road, 1 June 1974, *W. Botham* 1614 (CAN); Pelee Island, 22 June 1975, *W. Botham* 1762 (TRT).

Reported by Dodge (1914) for Middle Sister and Chicken Islands in the Canadian Erie archipelago, this constitutes the first record of this plant from Pelee Island. These stations on the Erie islands constitute the only native Canadian occurrences; collections from a clover field in the Central Experimental Farm (*W. T. Macoun*, 3 June 1898, DAO; July 1898, CAN) are surely chance introductions.

Conoclea multifida (Michx.) Bentham

Pelee Island, Stone Road, 13 June 1974, *W. Botham* 1672 (CAN); J. Harris lane behind barn, Lighthouse Point, muddy depressions, 19 September 1974, *Reznicek and Diebolt* (WLU); and Lighthouse Point, Lake Henry, mudflats, 19 September 1974, *Reznicek, Campbell and Diebolt* (WLU).

This obscure member of the Scrophulariaceae has been collected previously on Pelee Island a number of times (Soper 1962) but nowhere else in Canada. Our collections extend its occurrence from the south parts of the island to the north end. It also occurs on Kelley's Island, Ohio (Core 1948).

Eupatorium altissimum L. Tall Boneset

Essex County, Maidstone Township, RR at C3, 42°11'N, 82°46'W, 10 September 1968, *W. Botham*

TABLE 1—Species new to the Erie Archipelago, Pelee Island, and East Sister Island

Species	Erie Archipelago	Pelee Island	East Sister Island
<i>Potamogeton crispus</i>		x	
<i>Potamogeton foliosus</i>		x	
<i>Butomus umbellatus</i>		x	x
<i>Bromus japonicus</i>	x	x	
<i>Hordeum jubatum</i>		x	
<i>Muhlenbergia schreberi</i>		x	
<i>Phalaris arundinacea</i>		x	
<i>Panicum philadelphicum</i>	x	x	
<i>Panicum dichotomiflorum</i>	x	x	
<i>Cyperus erythrorhizos</i>		x	
<i>Carex sartwellii</i>	x	x	
<i>Wolffia punctata</i>	x	x	
<i>Wolffia columbiana</i>		x	
<i>Commelina communis</i>		x	
<i>Heteranthera dubia</i>		x	
<i>Zigadenus glaucus</i>	x	x	
<i>Smilax tanninoides</i> var. <i>hispida</i>		x	
<i>Iris pseudacorus</i>	x	x	
<i>Carya ovalis</i>	x	x	
<i>Quercus palustris</i>	x	x	
<i>Quercus velutina</i>		x	
<i>Rumex maritimus</i>			x
<i>Cycloloma atriplicifolium</i>	x	x	
<i>Diplotaxis muralis</i>		x	
<i>Diplotaxis tenuifolia</i>	x	x	
<i>Lunaria annua</i>	x	x	
<i>Rorippa islandica</i>			x
<i>Sedum sarmentosum</i>	x	x	
<i>Potentilla argentea</i>	x	x	
<i>Rosa palustris</i>		x	
<i>Lotus corniculatus</i>	x	x	
<i>Euphorbia dentata</i>		x	
<i>Euphorbia cyparissias</i>		x	
<i>Euonymus atropurpureus</i>			x
<i>Acer nigrum</i>			x
<i>Lythrum alatum</i>		x	
<i>Ludwigia palustris</i>	x	x	
<i>Oenothera parviflora</i>	x	x	
<i>Myriophyllum spicatum</i>	x	x	
<i>Osmorhiza longistylis</i>			x
<i>Ipomea purpurea</i>		x	
<i>Hydrophyllum virginianum</i>			x
<i>Myosotis verna</i>		x	
<i>Physostegia virginiana</i>		x	
<i>Lamium amplexicaule</i>		x	
<i>Lamium purpureum</i>		x	
<i>Lindernia dubia</i>		x	
<i>Linaria dalmatica</i>	x	x	
<i>Viburnum rafinesquianum</i>		x	
<i>Lobelia cardinalis</i>		x	
<i>Bidens connata</i>		x	
<i>Xanthium strumarium</i>		x	
<i>Gnaphalium uliginosum</i>	x	x	
<i>Tussilago farfara</i>	x	x	
<i>Tragopogon dubius</i>	x	x	

821 (CAN); Pelee Island, Stone Road savanna, 15 September 1972, *Campbell and Donaldson* (WLU); Stone Road, dry open savanna, 7 August 1974, *Campbell, Reznicek and Donaldson* (CAN, WLU); and E-W road, west end (north side), red cedar savanna glade, 25–26 September 1976, *Campbell, Francis and Diebolt* (DAO).

First collected on the Ontario mainland in 1968, and subsequently on Pelee Island, this prairie species was also collected, as a probable adventive, along a railroad in Dundas (Pringle 1974). Core (1948) recorded it from Kelley's Island, Ohio, as well. Few plants exist at the Pelee Island sites.

Eclipta prostrata (L.) L. (*E. alba* (L.) Hass.) Yerba-de-Tago

Essex County, Malden Township, east of Amherstburg, Concession III, 42° 16' N, 83° 06' W, ditch, 12 September 1971, *W. Botham* 1359 (CAN).

Pelee Island, Fish Point, sandy gravelly shore of lagoon, 7 August 1974, *Reznicek, Campbell and Donaldson* s.n. (CAN, WLU); and Lighthouse Point, new dike, disturbed soil behind J. Harris farm, 4 September 1974, *Campbell and Donaldson* (CAN).

The first Canadian collection of this species was 5 September 1905, on Point Pelee (Klugh 1906), but it was not reported in Canada again until Core (1948) noted it from Pelee Island. Duncan and Stuckey (1970) had recorded it from Lost Ballast Island, Ohio, from where it later disappeared. It is a semi-cosmopolitan, subtropical annual.

New Records in the Erie Islands Flora

Comparison of our collections with Calvert (1920), Core (1948), Boivin (1953), Stuckey (1968), Duncan and Stuckey (1970), Duncan (1973), and Stuckey (1975) has disclosed that a number of species were new to the Erie Archipelago, Pelee Island, or East Sister Island. These are listed in Table 1. The vouchers for all these records are in WLU except for *Zigadenus glaucus* which is in Herbarium W. Botham and *Rosa palustris* which is in the Rondeau Provincial Park Herbarium.

Discussion

Although many of the species we have recorded were undoubtedly overlooked by earlier authors, some species have probably spread from the south to Pelee Island recently. Deam (1940) noted at that time that species like *Senecio glabellus* and *Eclipta prostrata* were spreading northward. *Ammannia coccinea* was

reported by Core (1950) and Stuckey (1968) from the north shore of Ohio, and has now reached Pelee Island and Wheatley. *Senecio glabellus* has spread to some other Erie Islands as well (Stuckey 1975). The recent floods on Pelee Island (1972–73) may well have opened new bare habitat for these species and possibly others like *Conobea multifida* and *Cyperus* spp.

A number of the rare species reported upon are concentrated in several of the outstanding natural areas left on Pelee Island. Chief among these is the Stone Road savanna (Figure 1), where *Chaerophyllum procumbens* var. *shortii*, *Eupatorium altissimum*, *Phacelia purshii*, and *Spiranthes magnicamporum* occur. On the more wooded edges of this savanna occur *Triosteum angustifolium*, *Valerianella intermedia*, and *V. umbilicata*, as well as *Ratibida pinnata* (Duncan 1973) which occurs elsewhere in southwestern Ontario but rarely. Brown's Woods or Middle Point (Figure 1) contains a rich assemblage of uncommon species, including *Camassia scilloides*, *Chaerophyllum procumbens* var. *procumbens*, *Corydalis flavula*, *Euonymus atropurpureus*, and *Myosotis macrosperma*.

Both the Stone Road savanna and Brown's Woods are threatened with housing developments in the near future. Pelee Island has some of the finest southern plant communities in Canada, and the loss of any one of these would be serious.

Fish Point (Figure 1) is one of the most remarkable, and largest, areas of natural woodland left on Pelee Island. The point has *Celtis tenuifolia* and *Lycopus virginicus* as two of its more interesting southern species, together with *Camassia scilloides*, *Chenopodium foggii*, *Hydrophyllum appendiculatum*, *Morus rubra*, and *Myosotis macrosperma*. The so-called 'Verbeek savanna' (Figure 1) on Lighthouse Point contains scattered individuals of *Chenopodium foggii*, *Corydalis flavula*, and *Euphorbia obtusata*. There are also uncommon species associated with these, such as *Allium cernuum*, and a fine stand of *Fraxinus quadrangulata*, probably the best representation in Canada.

The flooding of the north-central portion of Lighthouse Point (Figure 1) has created 'Lake Henry' and attendant large areas of drying shoreline. On the drying shores occurs a most interesting early successional flora. Notable

species encountered in 1974 and 1975 were *Ammannia coccinea*, *Conobea multifida*, *Eclipta prostrata*, *Cyperus odoratus* var. *squarrosus*, and *Cyperus erythrorhizos*.

The last three areas mentioned have been purchased by the Ministry of Natural Resources and the Essex Region Conservation Authority. These are currently designated as Provincial Nature Reserves. We are hopeful that these areas will remain protected from all destructive uses and well buffered from any development. Most of the species mentioned in this article will be placed on the Ontario Endangered Plant lists (G. W. Argus, personal communication 1976).

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Notes

Geographic Variation in Dunlins, *Calidris alpina*, of North America

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An evaluation of the geographic variation in Dunlins, *Calidris alpina*, of North America reveals that the northern Alaska population of the species is distinct from the race of Siberia and that the populations of northeastern Canada deserve nomenclatural recognition. Thus, three races should be recognized as breeding in North America: *arctica* Todd, a short-billed race of northern Alaska; *pacifica* Coues, a longer-billed race of western Alaska; and *hudsonia* Todd, a race having dark shaft streaks of the undertail coverts, that breeds in northeastern Canada.

Key Words: Geographic variation, *Calidris alpina*, Dunlin, taxonomy, winter plumage.

In a recent review of Dunlins, *Calidris alpina*, MacLean and Holmes (1971) concluded that three races breed in North America. They considered the race breeding in northern Alaska to be *sakhalina* Vieillot (type locality: Sakhalin Island), a pale-backed and short-billed race that also breeds in northeastern Siberia. The breeding form of western Alaska was considered to be *pacifica* Coues (type locality: Simiahmoo, Washington), a darker-backed and longer-billed race. MacLean and Holmes also recognized *hudsonia* Todd (type locality: Southampton Island, Northwest Territories), a race similar to *pacifica*, as the breeding form of northcentral Canada. The AOU Check-list (1957), however, recognized *pacifica* as the only race breeding in North America.

Separation of the races of *C. alpina* has been based primarily on the differences in length of culmen and in dorsal coloration. MacLean and Holmes (1971) considered *sakhalina* to be the breeding race of eastern Siberia and northern Alaska based only on length of culmen since they regarded the differences in dorsal coloration of specimens from the two regions as representing individual variation. MacLean and Holmes (1971, p. 895) stated that their measurements of exposed culmen of specimens from northern Alaska are "indistinguishable" from those of specimens from Siberia measured by them and by Kozlova (1962). Measurements made by MacLean and Holmes revealed that birds from northern Alaska have means in length of culmen that are slightly greater in males, yet slightly smaller in females when compared to their series from Siberia (Table 1).

I examined specimens of *C. alpina* for variation in size and color. There is little variation in wing chord and length of tarsus between North American populations (cf., Todd 1953; MacLean and Holmes 1971); therefore these measurements are not considered further. Measurements of exposed culmen were used

to evaluate variation in size. I employed Student's *t*-test to demonstrate statistical differences between samples but this was not the only basis for deriving taxonomic conclusions. Although most of my samples are smaller than those of MacLean and Holmes, my samples are sufficiently large for statistical comparisons.

I compared measurements of exposed culmen of specimens from Alaska and northeastern Siberia. The means of the exposed culmen of birds from western Alaska are greater than those from northern Alaska (Table 1). Statistical differences between these samples are highly significant for males ($t = 8.02$) and females ($t = 5.05$). Specimens from northern Alaska have means slightly greater than those from northeastern Siberia in males ($t = 1.90$, $P < 0.05$) and females ($t = 1.37$, $P < 0.10$). These statistical differences between the samples suggest that the close relationship of the northern Alaskan sample with birds from Siberia was oversimplified by MacLean and Holmes, and that especially on the basis of males, the two populations are not indistinguishable as they claimed.

I found that the dorsal coloration of specimens from northern Alaska is similar to that of birds from western Alaska and migrants in comparable plumage collected from the west coast of North America in May and early June. Compared with breeding adults collected at Gizhiga in Siberia, the northern Alaska specimens have darker but brighter dorsal coloration. This difference in dorsal coloration between specimens from northern Alaska and northeastern Asia has previously been reported by Conover (1945), Todd (1953), and Vaurie (1965). On the basis of dorsal coloration I found the northern Alaskan birds were similar to *pacifica*, but separable from *sakhalina* of northeastern Asia. Although I found some overlap in dorsal coloration the population of *C. alpina* of northern Alaska are characterized as darker-backed

TABLE 1—Comparison of the length of exposed culmen (in millimetres) of adult *Calidris alpina* from North America and northeastern Asia

Locality	Males			Females		
	Range	n	Mean \pm SD	Range	n	Mean \pm SD
Pt. Barrow, Alaska, breeding:						
This study	29.8–38.7	56	33.6 \pm 1.7	31.3–39.8	47	36.4 \pm 1.8
MacLean & Holmes (1971)	30.5–36.5	25	33.7	34.5–38.5	25	37.0
<i>arctica</i> (Todd 1953)	33.0–35.0	10	33.7	34.0–39.5	8	37.0
NE Asia, breeding:						
This study	29.7–35.7	21	32.8 \pm 1.5	33.8–40.1	12	37.2 \pm 1.8
MacLean & Holmes (1971)	30.0–37.0	41	32.9	33.0–41.0	20	37.3
<i>sakhalina</i> (Kozlova 1962)	29.0–38.8	16	34.1	33.0–39.8	18	37.1
Western Alaska, breeding:						
This study	32.5–40.5	27	36.8–1.7	35.8–41.4	15	39.1 \pm 1.8
MacLean & Holmes (1971)	32.0–40.0	55	36.4	37.0–42.0	29	40.1
<i>pacifica</i> (Todd 1953)	35.0–43.0	10	37.4	38.0–43.5	10	41.4
Northern Canada, breeding:						
This study	34.5–39.3	19	36.1 \pm 1.2	37.5–40.9	8	39.0–1.2
MacLean & Holmes (1971)	33.0–39.0	23	36.2	37.0–43.0	17	39.4
<i>hudsonia</i> (Todd 1953)	35.0–38.5	10	36.0	37.0–41.0	10	39.0
Western North America, migrants:						
This study	34.3–41.5	45	37.1 \pm 1.5	34.8–44.3	46	40.0 \pm 2.2
MacLean & Holmes (1971)	34.0–41.0	112	37.2	34.5–45.0	111	40.5
Northeastern Asia, migrants:						
This study	32.2–38.8	13	34.8 \pm 2.1	31.3–40.4	19	35.5 \pm 2.7
MacLean & Holmes (1971)	30.0–36.5	46	33.2	32.5–40.5	33	36.8

than birds from northeastern Asia (*sakhalina*) and, in exposed culmen, somewhat intermediate between populations from western Alaska and those from northeastern Asia but closer in culmen length to the latter populations.

Because of differences in exposed culmen between birds from northern Alaska and western Alaska, Todd (1953) named the northern Alaskan form *arctica*, which he characterized as having a shorter exposed culmen than *pacifica* and darker above than *sakhalina* from Siberia. I agree with Todd that the birds from northern Alaska that he named *arctica* are sufficiently distinct to warrant recognition. Furthermore, Holmes (1966a, b, 1970, 1971) has shown that there are differences in breeding density and temporality of breeding behavior between birds from northern and western Alaska.

Specimens from northeastern Canada were assigned to the race *hudsonia* by Todd (1953) and by MacLean and Holmes (1971). I found the plumage characters ascribed to *hudsonia* by Todd are not distinct from those of other populations of *C. alpina* in North America. Moreover, the length of exposed culmen of my sample of *hudsonia* is similar to that of *pacifica* (Table 1). As pointed out by Kenneth C. Parkes (personal communication, 1976), however, there are plumage characters that allow separation of *hudsonia* from *pacifica*. Parkes described the alter-

nate plumage of *pacifica* as having immaculate white shafts of the undertail coverts. Only very rare individuals of *pacifica* were said to have one or two feathers with dark hairline shaft streaks. Parkes also found that in *hudsonia* shaft streaks were present that extended from the flank feathers posteriorly to the black abdominal patch, and in some individuals the streaks include the white lateral upper tail coverts. In contrast, the streaks or spots on the flank feathers of *pacifica* almost always terminate anterior to the end of the black abdominal patch. According to Parkes, in basic plumage, specimens of *hudsonia* have gray streaks on the flank feathers that usually extend to the most posterior feather, even when faint, whereas in *pacifica*, these markings were described as usually confined to the anterior half of the underparts. Thus, as stated by Parkes, specimens of *hudsonia* and *pacifica* may be distinguished even in non-breeding plumages. Specimens at the U.S. National Museum of Natural History completely support Parkes' observations. I also examined *arctica* and *sakhalina* for streaking and found specimens representing both races to be identical to *pacifica*. On the basis of these characters I also consider *hudsonia* a recognizable race.

Three races of *C. alpina* should be recognized as breeding in North America. The race breeding in northern Alaska, *arctica*, characterized by its dark

dorsal color and short culmen, probably migrates to Asia, as suggested by MacLean and Holmes (1971; see also Norton 1971). Birds breeding in western Alaska, *pacifica*, are longer-billed and dark above, and winter in western North America. Another long-billed race, *hudsonia*, further characterized by its dark flank streaks and dark shaft streaks of the undertail coverts, breeds in northeastern Canada and migrates southward to eastern North America.

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Record of an American Robin Killing a Shrew

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On 24 October 1976, Penny observed an American Robin (*Turdus migratorius*) taking a shrew, probably either *Sorex cinereus* or *Microsorex hoyi*, as determined from photographs, at the Taiga Biological Station, Wallace Lake, Manitoba. The robin was first noticed chasing the shrew on a grassy area in front of a cabin. It ran after and pecked the shrew 5 times, lifted it off the ground, and threw it into the air. Eventually the robin picked up the now apparently dead animal, flew to a small knoll, and there proceeded to peck and shake the shrew for a few minutes. Then the bird flew out of sight: it is not known whether the robin flew off with the shrew or whether the shrew was eaten.

There are apparently no records of an American Robin actively chasing and killing mammals. L. R. Powers (1973, *Condor* 75: 248) reports a pair of robins feeding two shrews to their nestlings, and A. C. Bent (1964, *United States National Museum Bulletin* 196: 50-51) relates an instance of a robin eating a field mouse, but in neither case is it known whether the animals were taken alive or found dead.

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First Record of Anna's Hummingbird for Alberta

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Pinel, Harold W. and John R. Riddell. 1977. First record of Anna's Hummingbird for Alberta. *Canadian Field-Naturalist* 91(4): 394.

On 6 October 1976 an Anna's Hummingbird (*Calypte anna*) was observed by the authors in Calgary, Alberta at the home of Kay and M. Mykulak. On 7 October the hummingbird's song was recorded by the authors, and the bird was subsequently photographed by R. Butot and A. Hanners. The tape-recording and photographs are on file at the Provincial Museum of Alberta. The hummingbird remained in the vicinity until 31 October (Kay Mykulak, personal communication). The identification of the bird as an immature male Anna's Hummingbird was accepted by the Alberta Ornithological Records Committee.

Initial observations indicated this bird was not one of Alberta's known hummingbird species because of its large size, habit of singing while perched, and overall color pattern. Closer examination revealed the crimson-violet cap when the bird was in direct sunlight. Further details observed, based on our field notes, include a green nape, back, shoulder patch, and rump with blackish-gray outer tail feathers and primaries. The tail was slightly forked. Under tail coverts were white with five dark gray spots, two pairs immediately posterior to the vent and a fifth most distal spot. The spots became progressively larger posteriorly. Chest and abdomen were white with horizontal dark grayish-green spots and streaks concentrating in the center of the chest to form an apparent breast spot. A white necklace tapering to the nape separated the chest from the throat area. The throat area was white with black streaks and two triangular areas, one under each eye. These black streaks and triangles appeared crimson-violet in direct sunlight. A teardrop-shaped white area was evident behind the eye and a black streak was noted tapering to the bill from the front of the eye. The bill appeared large and slightly decurved.

The above observations were made with the use of binoculars and a 20× wide-angle spotting scope. The bird was always very vocal while perched. The bill was held above the horizontal when the bird sang. Its favorite perch was in a lilac shrub (*Syringa vulgaris*) 1 m off the ground. The bird made frequent visits to artificial bird feeders in the back yard.

The first reported sighting of this species in Canada was at Metchosin, British Columbia, in August 1958,

and to date there are 131 observations from British Columbia (C. J. Guiguet, personal communication); the most easterly is at Shuswap Lake. Godfrey (1966) acknowledged the sight records from British Columbia but listed the species as hypothetical. On 2 January 1968 the first specimen record in Canada was obtained (Guiguet 1968).

Since 1971 this species has become recognized as a fairly regular visitor in Alaska (Gibson 1972; Gibson and Byrd 1974, 1975). Zimmerman (1973) considers a 1969 record from Missoula, Montana, as the most surprising in North America, the implication being that its easterly location, almost due south of Calgary, is significant. The Alberta record is the only sighting east of the continental divide north of Texas, and is thus noteworthy in a largely non-migratory species.

Zimmerman (1973) notes that most reports of this species outside California are from suburban areas. He postulates that this is a result of a great increase in artificial feeders and an abundance of exotic flowering plants which provide an invaluable source of food during the period when the native flora is dormant. The Alberta record was in a suburban setting richly supplied with exotic plants and artificial feeders.

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Le Ver Québécois (*Lumbricus festivus*) Envahit la Colombie-Britannique

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Reynolds, John W. 1977. Le ver québécois (*Lumbricus festivus*) envahit la Colombie-Britannique. *Canadian Field-Naturalist* 91(4): 395-396.

Until now the known North American distribution of *Lumbricus festivus*, or the Quebec worm, has been restricted to southern Quebec. The species is also present in the provinces of British Columbia, Ontario, New Brunswick, and the state of Vermont. *Lumbricus festivus* has been found in species associations with most of the lumbricids recorded for Canada. Species associations for *L. festivus* in North America range from one to six; the most frequent association is with two other species. The genital tumescences on setae *a* and *b* of segments xxix and xxx are constant for specimens collected in eastern North America but variable for those specimens received from British Columbia.

Lumbricus festivus (Savigny, 1826), ou le ver québécois, est un exotique lombric européen signalé pour la première fois en Amérique du Nord par Stafford (1902). Il a simplement mentionné, "from Ontario, Quebec, New Brunswick and Nova Scotia" sans renseignement au sujet des habitats ou des endroits. Le deuxième rapport, fondé sur une antécédentielle, fut fait par Langmaid (1964) du Comté de Victoria, Nouveau-Brunswick. Dans mes récents échantillonnages de lombrics effectués au Nouveau-Brunswick, en Nouvelle-Ecosse, aux Îles-de-la-Madeleine et à l'Île-du-Prince-Édouard (Reynolds 1975a, b, c, 1976a, b), je n'ai pas trouvé de *L. festivus*. Bien que ne publié que récemment (Reynolds 1977), un échantillonnage en 1972-73 de l'Ontario révèle cette espèce à 10 localités dans sept des comtés de l'est. Des échantillonnages subséquents au Québec (Reynolds 1975d, e, 1976c, données inédites) ont révélé cette espèce à 52 localités dans 35 comtés sur les deux rives du fleuve Saint-Laurent. Pendant cette même période, une clitellienne de *L. festivus* fut trouvée à un endroit dans un comté à la frontière de l'état du Vermont (Reynolds 1976c). Au début de 1977 la répartition connue de *L. festivus* en Amérique du Nord était centrée dans la vallée du Saint-Laurent et presque exclusivement au sud du Québec.

Reynolds (1977, pp. 92-94) a présenté la synonymie détaillée, la diagnose, les tirages longitudinaux externes, la biologie et la répartition en Amérique du Nord et en Ontario avec une carte de distribution de *L. festivus*.

Quand les protocoles d'échantillonnage sont suivis soigneusement, les espèces de vers de terre se trouvent en association. Le tableau I indique la fréquence du nombre d'espèces associées à *L. festivus* en Amérique du Nord. Les associations varient considérablement en importance selon l'habitat et la géographie.

TABEAU I—Fréquence du nombre d'espèces de vers de terre associé à *Lumbricus festivus* en Amérique du Nord

Région	Nombre de localités	Nombre d'espèces trouvées en association avec <i>L. festivus</i>					
		0	1	2	3	4	5
Colombie-Britannique	6	0	0	4	1	0	0
Ontario	10	0	2	5	1	2	0
Québec	52	7	11	16	11	5	2
Nouveau-Brunswick	1	0	0	1	0	0	0
Vermont (E.U.)	1	0	0	0	0	1	0

Reynolds a révisé (1973; 1977, p. 121) les associations déjà établies pour différents habitats.

Récemment nous avons reçu 120 échantillons de vers de terre du sud de la Colombie-Britannique. Six endroits dans un champ contenaient le *L. festivus*. C'est la première fois que l'on rapporte cette espèce en Amérique du Nord ailleurs que dans la vallée du Saint-Laurent. Le *L. rubellus* fut également trouvé dans tous les six prélèvements, *Octolasion tyrtaeum* dans cinq prélèvements et *Aporrectodea tuberculata* dans deux prélèvements. Dans les échantillons du Québec, le *L. festivus* fut trouvé quelques fois en association avec toutes les espèces de vers de terre de la province, sauf *Octolasion cyaneum*. Le *L. festivus* fut trouvé en association surtout avec *Aporrectodea turgida* (45% des 52 prélèvements), *Allolobophora chlorotica* et *Aporrectodea tuberculata* (26%), *Dendrodriilus rubidus* (19%), *Dendrobaena octaedra* (16%) et les huit espèces qui restent dans < 10% des prélèvements. Aux dix localités de l'Ontario, le ver québécois fut trouvé sept fois en association avec



FIGURE 1. La répartition connue de *Lumbricus festivus* en Amérique du Nord.

Eisenia rosea, six fois avec *Aporrectodea tuberculata*, trois fois chacun avec *Allolobophora chlorotica* et *Aporrectodea turgida* et une fois chacun avec *Aporrectodea trapezoides*, *Dendrobaena octaedra*, *Eiseniella tetraedra* et *O. tyriaeum*. Un prélèvement au Nouveau-Brunswick contenait *Aporrectodea tuberculata* et *L. terrestris*, tandis qu'un seul prélèvement au Vermont contenait ces deux espèces de même que *Dendrobaena octaedra* et *L. rubellus*.

Les soies ventrales sur certains segments dans trois des quatre espèces de *Lumbricus* rapportées en Amérique du Nord sont sur les papilles puberculienues. A l'est de l'Amérique du Nord, *L. festivus* porte sur les papilles puberculienues les soies *a* et *b* des deux côtés des segments xxix et xxx. Les spécimens de *L. festivus* de Colombie-Britannique portent sur les papilles puberculienues les soies *a* et *b* des deux côtés des segments xxix (un spécimen), xxix et xxx (six spécimens) et xxx (un spécimen). Un spécimen n'a pas des soies sur les papilles puberculienues des segments xxix ou xxx et un autre spécimen porte les soies *a* et *b* sur les papilles puberculienues d'un côté seulement du segment xxix. Les spécimens de *L. festivus* avec des spermatophores n'ont été trouvés qu'au Québec (Reynolds 1977, p. 92).

Ces récents échantillons de la Colombie-Britannique créent maintenant un éparpillement plus grand dans la répartition de *L. festivus* en Amérique du Nord (Figure 1). Il y avait 19 espèces de vers de terre signalées en Ontario (et au Canada) par Reynolds (1977). Les autres provinces de l'est ont été prospec-

tées méthodiquement: 13 à 16 espèces de vers de terre ont été trouvées dans chacune. Cette mention de *L. festivus* en Colombie-Britannique augmente la liste provinciale des vers de terre à 14 espèces. Les trois provinces des prairies ont moins de vers de terre inventoriés (Alberta 5, Saskatchewan 1, Manitoba 7). Cette situation est probablement due à un manque d'échantillonnage plutôt qu'à une absence des vers de terre.

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Melanistic Butler's Garter Snakes (*Thamnophis butleri*) at Amherstburg, Ontario

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Catling, P. M. and W. Freedman. 1977. Melanistic Butler's Garter Snakes (*Thamnophis butleri*) at Amherstburg, Ontario. Canadian Field-Naturalist 91(4): 397-399

Three melanistic adults and some melanistic young of *Thamnophis butleri*, are described from an abandoned quarry near Amherstburg, Ontario. This represents the first record of melanism in *T. butleri*. Comparison is made with the melanistic phase of *Thamnophis sirtalis sirtalis*. The ratios of melano to normal in broods from both normal and melanistic females of *T. butleri* are discussed with respect to the predictions of simple Mendelian genetics, with melanism assumed to be a recessive trait.

Key Words: melanism, *Thamnophis butleri*, Garter Snake, Ontario, recessive trait, genetics.

During a study of snake populations in an old limestone quarry approximately 3 km north of Amherstburg (42°07' N, 83°05' W), Essex County, Ontario, we found three melanistic adult Butler's Garter Snakes (*Thamnophis butleri*), which apparently represent the first records of melanism in this species. The first of these melanos, captured on 14 May 1976, is a female with total body length of 54.2 cm; the second, captured on 13 June 1976, is a male 42.2 cm long; the third, captured on 7 May 1977, is a female 34.5 cm long. Of 300 adult Butler Garter Snakes captured, marked, and released in the quarry area during the late spring and summer of 1976 and the early spring of 1977, only these three adults were melanistic.

These three snakes are very similar with an overall velvety black appearance above and differ markedly from normal Butler's Garter Snakes (Figures 1 and 2). The dorsal and lateral stripes are very dark grayish-olive, becoming lighter prior to shedding. The lower lateral parts and venter are more lustrous and blackish-brown, the brown becoming more apparent toward the lateral stripes. The venter becomes grayish-blue during the pre-shedding dull stage, especially anteriorly. An exception to this overall blackish coloration is the whitish edge of the scales on the chin, beginning with the chin shields and including the first few ventral plates. The only other exceptions include the bright yellow upper half of scale 40 in the third row on the right side of the larger female, and a bright yellow lower half of scale 33 in the fourth row on the left side of the male.

Scale counts for two of the three melanistic snakes are summarized in Table 1, and fall well within the normal range of *T. butleri*. Various characteristic features of *T. butleri* are readily apparent in our melanistic specimens, such as the relatively small head, relatively small eyes, prominent brownish



FIGURE 1. Normal striped and melanistic *T. butleri* from Amherstburg, Ontario. Both snakes are females, and the melanistic individual is 54.2 cm long and 1.1 cm across the head.

marking on the sides below the lateral stripe, position of the lateral stripe centered on the third scale row, and prehensile behavior when held.

The three melanistic adults, as well as some melanistic young resulting from pre-captivity mating of the large female, were kept in captivity for several sheddings. There was absolutely no change in coloration. It appears that the melanistic snakes are black from birth and never change their appearance.

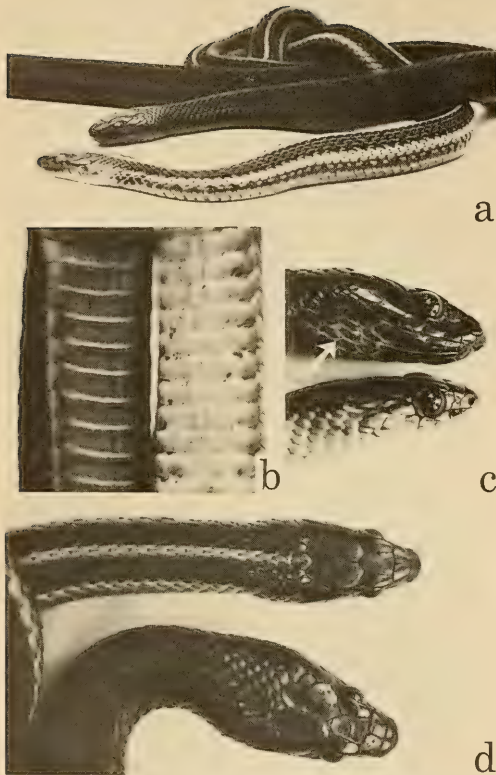


FIGURE 2. Detail of snakes shown in Figure 1. (a) Anterior lateral view. (b) Ventral aspect at middle of body, melanistic female to the left. (c) Lateral aspect of head, melanistic female above with white edging on chin shields (arrow) distinguishable from glare on upper labials. (d) Anterior dorsal aspect.

The melanistic *T. butleri* described above differ somewhat from the melanistic phase of the Common Garter Snake (*Thamnophis sirtalis sirtalis*) as described from the Lake Erie region by various authors (e.g., Blanchard and Blanchard 1940; Logier 1929, 1958; From 1972). Specifically the melanistic *T. butleri* differ from melanistic *T. sirtalis* in having the white on the throat much less well developed, the lateral and dorsal stripes somewhat more conspicuous, and in having dark brown coloration below the lateral stripes and extending onto the venter. In melanistic *T. sirtalis*, the dorsal and lateral stripes are never continuous and never show the normal coloration. When present these stripes are limited to a few white or cream-colored scales within 2–5 cm posterior to the head. Also, melanistic *T. sirtalis* never show

normal or even near-normal coloration below the lateral stripes or on the ventral surface (A. R. Gibson, personal communication).

The mating experiments of Blanchard and Blanchard (1940) suggested that melanism in *T. sirtalis* from Lake Erie is dependent upon a single Mendelian recessive factor.

The large melanistic female gave birth on 14 July 1976 to three normal and six melanistic young. If melanism in *T. butleri* is governed by a simple Mendelian recessive factor then we would expect a 1:1 ratio of normal to melanistic young if she had mated with a normally colored but heterozygous male. Mating with homozygous males would result in either all normal or all melanistic young.

Our ratio of 1 normal:2 melanistic offspring may be explained in a number of ways. Blanchard and Blanchard (1940), and more recently Gibson and Falls (1975), were of the opinion that more than one male could be represented in broods where Mendelian ratios are not exact, either through double copulations or second matings. It is important to bear in mind, however, that with small samples of offspring, deviations of one or two from Mendelian prediction may not be significant.

Five normally colored pregnant females from the Amherstburg quarry were brought into captivity so as to record both the number of broods with melanistic young, and the color phase ratio of the young. All of these females gave birth resulting in broods of 7–11 young, and one brood of 10 contained a melanistic

TABLE 1. Scutellation of female melanistic *Thamnophis butleri* from Amherstburg, Ontario

Body length (cm)	54.2	34.5
Scale rows 5 rows post. to neck	19	19
Mid-body	19	19
5 rows ant. to cloaca	17	17
Ventral plates	138	137
Caudal scales	59	57
Labials		
Upper right	6	6
Upper left	6	6
Lower right	7	7
Lower left	7	7
Preoculars		
Right	1	1
Left	1	1
Postoculars		
Right	2	3
Left	3	3

snake. From the crossing of two heterozygotes, Mendelian genetics would have predicted 2.5 melanos.

The newborn young in the quarry were surveyed on 10 and 11 July 1976. Although a total of 27 was captured, none of these were melanistic.

The above data may fit the assumption that melanism in the Amherstburg population of *T. butleri* is controlled by a simple recessive factor inherited in simple Mendelian fashion, as demonstrated for Lake Erie *T. sirtalis* (Blanchard and Blanchard 1940). The possibility of multiple inseminations (Gibson and Falls 1975), however, makes it impossible to base definite conclusions on morph frequencies in offspring of wild snakes. Rather, crossings will have to be made with captives of known genotype, kept in isolation.

All of the melanistic *T. butleri* from Amherstburg were released there later, excepting for the large adult female which died in captivity and was placed in the collection of the National Museum of Natural Sciences, Ottawa (No. 17686). In addition to this specimen, there are photographs on file at the National Museum and the Royal Ontario Museum, Toronto.

Acknowledgments

We gratefully acknowledge Francis Cook of the National Museum of Natural Sciences, Ottawa; Craig Campbell of Waterloo, Ontario; Janet Planck of Kitchener, Ontario; and Roger Conant of the University of New Mexico for their critical reading and helpful suggestions.

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An Improved Design for a Small Mammal Live Trap

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Inclusion of variable quantities of bait and nesting materials have frequently altered the sensitivity and effectiveness of small mammal live traps. An improved design of a light weight small mammal live trap is described in which the extreme sensitivity is unaffected by variations in quantity of either bait or nesting material placed inside.

Key Words: small mammal live trap, improved design, trap sensitivity, effectiveness.

Numerous articles published in past years have described small mammal populations in a diversity of habitats. A wide spectrum of techniques and field equipment used in obtaining the information render as questionable comparisons of trapping results. In describing small mammal populations, major emphasis is usually placed upon species present, numbers of animals handled, and floristic habitat. Only minor reference is usually made to field equipment used to obtain the data or the techniques employed.

Wiener and Smith (1972) compared the relative efficiencies of four types of small mammal traps in common use. Similar comparisons have been noted by Neal and Cock (1969), Edwards (1952), Smith et al.

(1971), Duran (1968), and Goodnight and Koestner (1942).

In small mammal studies over the past 17 years I have made extensive use of sheet-metal traps based on the Sherman live trap design. Although particular attention was repeatedly given to adjustment of the traps to ensure sufficient sensitivity to enable capture of even the smallest and most light-weight animals, several disadvantages inherent in the features of the traps became apparent and led to the design of an improved small mammal live trap outlined here.

Evans (1975) and Wiener and Smith (1972) emphasized the importance of adjusting trap sensitivity prior to use. Unfortunately the sensitivity can be

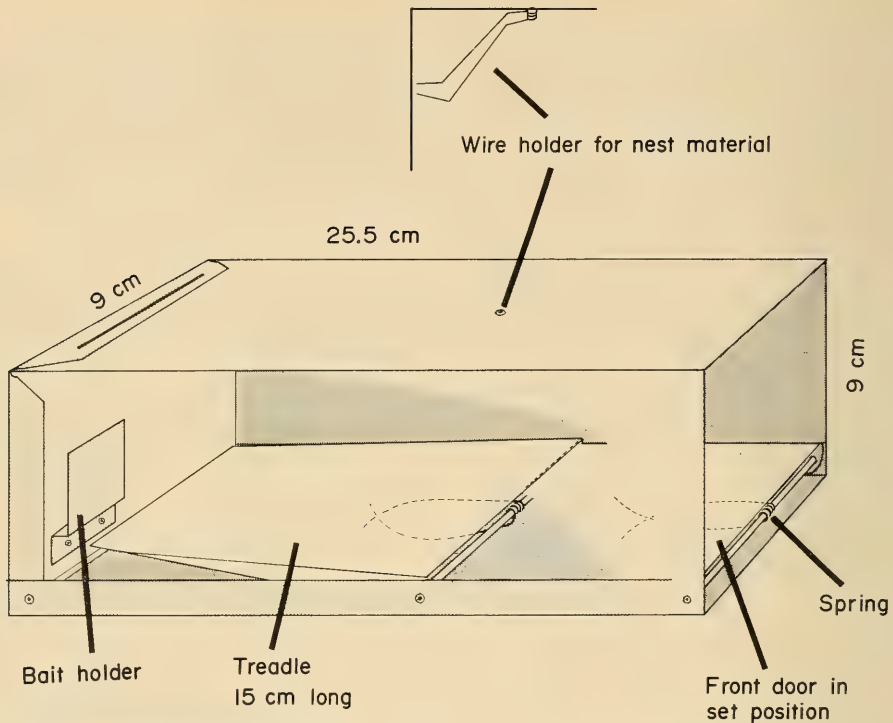


FIGURE 1. Cutaway schematic drawing of the improved small mammal live trap, shown in the set position.

altered by the amount of bait and nest material placed inside the trap. Application of peanut butter and oatmeal bait smeared onto the inside of the rear door (Wiener and Smith 1972) provides a partial solution to the trap sensitivity problem but limits the quantity of bait used in the trap. Sufficient food and nesting material must be included to sustain the captive animal until the traps are checked.

The problem of trap sensitivity being affected by varying weight of bait and nesting material appeared to have been solved in the live trap designed by Buech (1974). The Buech trap, although extremely sensitive to animal weight, cannot be set without first removing the lid. To set the trip mechanism, replace the lid, fasten the latter to the trap by means of two elastic bands, and then put the trap into place without springing it, requires extreme care.

The modifications incorporated in the new trap design are aimed at improving the shortcomings mentioned. The trap dimensions (Figure 1) can be altered to accommodate prey species. Although non-collapsible, the traps are of light-weight 0.030-gauge aluminum and weigh only approximately 206 g — an

important consideration when large numbers of traps must be packed into a remote study location. Theoretically the traps could be made collapsible by inclusion of appropriate interlocking piano hinge mechanisms along the long edges of the trap body, but to do so would increase appreciably the construction cost per trap.

The overlapping front door-treadle release mechanism is extremely sensitive. A penny weight (3.17 g) placed gently upon the distal end of the treadle is amply sufficient to spring the trap. The smallest of mammals we encountered in our field studies (i.e., *Sorex cinereus*) weigh 2.5 to 4.0 g and are readily captured in the traps. The new design lacks the brace plate extending across the proximal end of the treadle as found in the Sherman trap. Mice could conceivably perch on this plate and remove the bait beyond without activating the treadle release mechanism. In our trapping procedure a large tablespoonful of a paste bait and a small slice of apple are placed into the bait holder inside the back door of the trap.

As with the bait, the nesting material provided in

the trap does not contribute any additional weight onto the treadle release mechanism. The nesting material is inserted behind a short hooked wire fastened to a rivet in the trap ceiling.

The sensitivity of the trap is adjusted by the curvature put on the spring wires under the front door and treadle. The greater the bend in the ends of the wires, the greater the pressure exerted on the door and treadle while the trap is in the set position.

Unlike the Buech live trap, our trap can easily and quickly be reset from the closed position by inserting one hand inside the trap, pressing down on the front door and treadle until the former catches under the latter, and then withdrawing the hand — a 3- to 4-s operation.

Of 550 small mammals handled in 1691 captures and recaptures during our 1976 field season, trap casualties among captured mice amounted to only 2.7%, even though climatic conditions ranged from hot days to traps buried under 25.4–30.5 cm snow. A three-sided plywood and lumber sheltering device placed over each trap served to minimize animal losses due to temperature extremes and inadvertent springing of the sensitive traps by wind, rain, or hail.

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Collections of Spiders beneath Snow

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Observations of activities of invertebrates in snow environments have been recorded by relatively few workers. Novikov (1940), Chapman (1954), Wolska (1957), Strübing (1958), Kühnelt (1961), Kevan (1962), Näsmark (1964), Fjellberg and Greve (1968), Hågvar (1971, 1973), and Aitchison (1974) have found that a variety of invertebrates including insects and spiders are active on the snow surface as well as beneath the snow.

Spiders were collected throughout the winter of 1976–77 as part of a year-long ecological study on carabid beetles and their associated mite populations near Thunder Bay, Ontario. During the winter no beetles, but 13 spiders, were captured.

Two collecting sites were established in mixed spruce forest. One was beside Highway 11, 0.8 km from the junction of Highways 11 and 17, 65 km west of Thunder Bay and the other beside Gilbride Road near One Island Lake 32 km northwest of Thunder Bay. On each site were placed 100 dry pitfall traps

7 cm deep and 11.5 cm in diameter at the top. A piece of 1.5-cm-mesh chicken-wire, 15 cm square, covered each trap preventing the entrance of larger animals. Aluminum pie plates over each trap prevented the entrance of precipitation and debris.

The last pre-winter collection was made on 9 November, at which time patches of snow were present. After that date the traps were considered to be snowed-in for the winter. Activity was considered to be unlikely on the soil surface until a subnivean environment was established. Collections were made from 25 traps in each site early in each of the months January through April inclusive. By collecting from different traps each time, disturbance of snow cover was eliminated as a factor. On 6 April, all but 16 of the 50 traps checked were embedded in a layer of solid ice beneath a thin covering of snow. Nine of those 16 traps were also full of ice. The seven traps free of ice contained no specimens.

Thirteen spiders representing four species and three

TABLE 1—Spiders collected in winter 1977 beneath snow near Thunder Bay, Ontario

Date	Taxa	Number and sex	Snow depth (cm)
6 Jan.	Clubionidae:		
	<i>Agroeca ornata</i>	1 ♀	25
	Linyphiidae:		
	<i>Lepthyphantes zebra</i>	1 ♂	45
	Amaurobiidae:		
	<i>Calliopius euoplus</i>	3 ♀	45
	<i>Amaurobius borealis</i>	1 imm.	45
8 Feb.	<i>Amaurobius borealis</i>	2 ♀	45
7 Mar.	<i>Amaurobius borealis</i>	1 ♀	30
	<i>Amaurobius borealis</i>	1 ♀	50
6 Apr.	—	—	Snow patches

families were collected over the winter (Table 1). Nine of these spiders were either active when first observed in the traps or became active before they were placed in 70% ethanol in the field. The spiders captured are common leaf-litter inhabitants of boreal forests.

We thank R. E. Leech for the spider identifications, B. Barnes for technical assistance, and the National

Research Council of Canada for financial support (Grant No. A4888).

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Northern Range Extension for the Brassy Minnow in Northeastern Alberta

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Berry, David K. 1977. Northern range extension for the Brassy Minnow in northeastern Alberta. *Canadian Field-Naturalist* 91(4): 402-403.

In 1976 intensive sampling of the Athabasca River north of Fort McMurray provided several specimens identified as Brassy Minnow, *Hybognathus hankinsoni*. Previous records for this species are from the Milk River drainage in southeastern Alberta (Paetz and Nelson 1970), Musreau Lake of the Peace River drainage in northwestern Alberta (Bishop 1975), and a single specimen from the Athabasca system mentioned in Bishop (1975). This specimen was identified from collections made by W. E. Griffiths and D. B. Ferster (1973. Preliminary fisheries survey of the

Winefred Pelican Area. Alberta Department of Lands and Forests, Fish and Wildlife Division, Survey Report Series 19. 449 pp.), while they were surveying the upper House River (55°50'N, 112°20'W) south of Fort McMurray. The Brassy Minnow occurs from the Upper St. Lawrence River and Lake Champlain region of New York, west through southern Ontario and Michigan, west through the Arkansas and Missouri Rivers to Colorado, Wyoming, and Montana, north to Alberta, and in British Columbia in the lower Fraser River and headwaters of the Peace River

(Scott and Crossman 1973).

Nineteen specimens were collected in beach seines at three locations in the Athabasca River. On 19 July 1976, 14 Brassy Minnows were taken at the confluence of the Horse River (56°44'N, 111°28'W). In September four specimens were found in subsamples from island sites near Fort McMurray, while one specimen was collected 28 km further down river. In this region the Athabasca is a wide, slow, and highly turbid river. Most of the tributaries in the area are low-gradient brown-water streams.

Measurements made on the preserved sample were as follows: total length 49 to 72 mm; fork length 44 to 66 mm; lateral line scales 37 to 41 (mode 39); scales above lateral line six; anal and dorsal fin rays eight; scale radii 13 to 19. Four specimens have been placed in the Museum of Zoology, University of Alberta, Edmonton (UAMZ #3766).

McPhail and Lindsey (1970) hypothesized that a postglacial southeast drainage route existed, allowing the dispersal of fish from the Missouri system into northern waters; and predicted that the Brassy Minnow may be discovered in some additional Alberta or Saskatchewan waters that lie along the supposed dispersal route. Bishop (1975) supported the existence of such a route. The presence of Brassy

Minnow in the Athabasca drainage near Fort McMurray gives further support to the hypothesis and extends the known range northward in Alberta 510 km.

My thanks to Wayne Roberts, Museum of Zoology, University of Alberta, for his confirmation of my identification. The collection of Brassy Minnows from the Athabasca River was incidental to a larger study with funding from the Aquatic Fauna Committee of the Alberta Oil Sands Environmental Research Program.

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Distribution of the Auricled Twayblade Orchid (*Listera auriculata*) in Canada and Description of New Stations in Southern Ontario

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Whiting, R. Emerson and Paul M. Catling. 1977. Distribution of the auricled twayblade orchid (*Listera auriculata*) in Canada and description of new stations in southern Ontario. *Canadian Field-Naturalist* 91(4): 403-406.

On the basis of herbarium specimens overlooked by recent authors, the range of *Listera auriculata* Wiegand (Orchidaceae) is extended northwestward into Manitoba and northward in Ontario, Quebec, and Newfoundland. The known distribution in Ontario is also extended southward by recent discoveries at five locations in Hastings and Haliburton Counties. The newly discovered stations are described in terms of associated plant species and soil factors. Distribution maps for Canada and for southern Ontario are included.

Key Words: orchid, *Listera auriculata*, distribution, range, southern Ontario.

The auricled twayblade, *Listera auriculata* Wiegand, was one of the last species of the genus *Listera* to be described in North America (Wiegand 1899). Its distribution and habitat have not always been adequately reported, for the species is rare over much of its range and has been confused with other *Listera* species. Several recent botanical works, including those of Correll (1950), Fernald (1950), Gleason and Cronquist (1963), and Luer (1975), give a more

restricted distribution in Canada than the species actually has. The following collections indicate the presence of *L. auriculata* at locations, plotted in Figure 1, that are about 780 km northwest and 710 km north of the area of distribution shown by Luer (1975, p. 87).

Manitoba: Duck Mountain Provincial Park, Singush Lake, 51°36' N, 100°48' W, 21 July 1954, J. S. Rowe

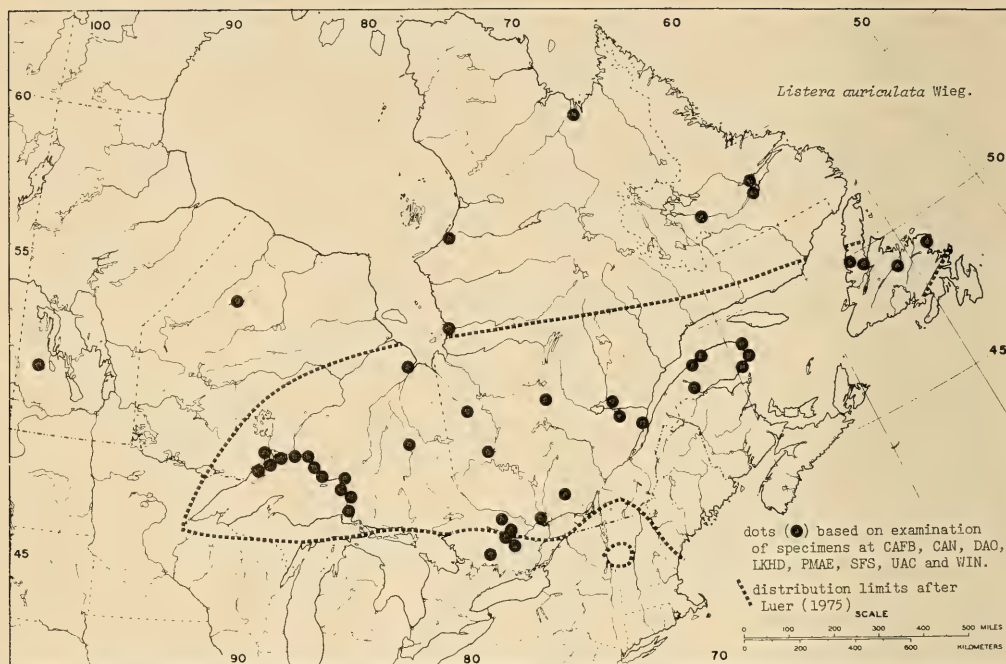


FIGURE 1. Canadian distribution of *Listera auriculata*, based on recently examined herbarium specimens and previous publication.

668 (DAO). This is the northwestern limit of presently known distribution.

Ontario: Kenora District, Big Trout Lake near Trout Lake Hudsons Bay Company post, 53°49' N, 89°53' W, 31 July 1956, *I. Hustich* 1630 (CAN).

Quebec: New Quebec Territory, Poste-de-la-Baleine (Great Whale River), Baie d'Hudson, ca. 55°17' N, 77°46' W, 4 August 1969, *S. Brisson* et *P. Forest* (LKHD, SFS);

New Quebec Territory, Fort Chimo area, Highfall Creek, 58°01' N, 68°29' W, 2 August 1967, *Y. Mäkinen* 67-1584 (sub *L. convallarioides* CAN). This specimen represents the northern limit of known distribution.

Newfoundland: Labrador West District, Hamilton River west of Lake Winikapau, 27 June 1967, *I. Hustich* 127 (CAN);

Labrador North District, northeast side of Grand Lake, 9 July 1967, *I. Hustich* 299 (CAN);

Labrador North District, Northwest River area, 9 July 1963, *I. Hustich* and *P. Kallio* 321 (CAN);

Labrador North District, Goose Bay, Hamilton River, 53°19' N, 60°21' W, 13 August 1949, *W. B. Schofield* (sub *L. cordata*, DAO).

The Canadian distribution map (Figure 1) suggests that the greatest frequency of occurrence is close to the shores of Lake Superior, but it should be remembered that these shores have been more extensively botanized than have areas to the west, north, and east. In northern Ontario there are only three adequately documented stations that are far from Lake Superior. In southern Ontario the auricled twayblade was first discovered in 1968, and at present we know of seven widely separated locations (Figure 2). Two of these have already been described: Renfrew County near Barry's Bay (MacKenzie and Greenwood 1969) and Nipissing District, Bronson Township (Brunton and Crins 1975). The other five stations are described below.

1. Haliburton County: Snowdon Township, 8 km northeast of Kinmount, 44°50' N, 78°34' W. Here, on 12 July 1974, we discovered two colonies of three and eight plants under conifers (*Abies balsamea*) and alders (*Alnus rugosa*), on sandy banks of the Irondale River (*R. E. Whiting*, TRT). This appears to be the southernmost station of *L. auriculata* in Canada, extending the known range about 75 km southwestward.

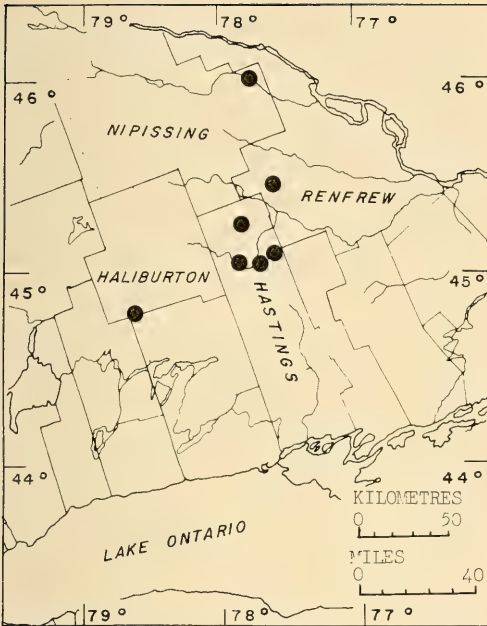


FIGURE 2. Distribution of *Listera auriculata* in southern Ontario, based on examination of specimens at CAN, DAO, LKHD, and TRT.

2. Hastings County: Faraday Township, 3 km north of Bancroft, 45°05' N, 77°52' W. Here, on 13 July 1974, we discovered about 50 plants rooted in acid sand of a seasonally flooded bank of the York River (P. M. Catling, R. E. Whiting and S. M. McKay, TRT). In addition to the prevalent alders, frequent associates were the moss *Atrichum crispum*, the liverwort *Pellia epiphylla*, and a sedge, *Carex intumescens*. Also present were *Picea glauca*, *Acer rubrum*, *Ilex verticillata*, and *Viburnum cassinoides*.

3. Hastings County: Dungan Township, 10 km east of Bancroft, 45°04' N, 77°44' W. On 13 July 1974 we saw 15 plants in loose sand of alder thickets along the east bank of the York River (P. M. Catling, R. E. Whiting and S. M. McKay, TRT).

4. Hastings County: Wicklow Township, near Maple Leaf, about 45°17' N, 77°49' W. *Listera auriculata* may be seen in at least three places in the Maple Leaf area.

(a) We were directed to this vicinity by L. G. Roberts (personal communication) who, on 3 July 1974, had seen 11 plants under alders beside Papineau Creek, 0.8 km north-northeast of Maple Leaf. Here, on 6 July 1976, we found about 60 shaded plants in acid sandy soil (pH 4.7–4.8) that had apparently been

deposited during spring flooding (P. M. Catling and R. E. Whiting, TRT).

(b) Farther downstream on Papineau Creek, about 2.5 km east of Maple Leaf and upstream from the site of an old sawmill, we found two colonies of three and nine plants (P. M. Catling and R. E. Whiting, TRT). Here the plants were growing in black muck of alder thickets at the base of a slope. Although the soil was composed of humus instead of sand, it was acid (pH 4.5) and probably subject to flooding during the early spring thaw. Prominent associates (in addition to the prevalent alder) included *Onoclea sensibilis*, *Athyrium filix-femina*, *Carex intumescens*, *Maianthemum canadense*, *Rubus pubescens*, and *Viola* sp.

(c) On Little Papineau Creek, about 4 km north-northeast of Maple Leaf, we discovered another colony of about 100 plants in acid sandy soil (pH 4.1–4.2) in periodically flooded alder thickets (P. M. Catling and R. E. Whiting, TRT). In addition to the associates listed above for station 2 on the York River, we saw here *Equisetum pratense*, *Onoclea sensibilis*, *Athyrium filix-femina*, *Glyceria striata*, *Carex crinita*, *Carex gracillima*, *Thalictrum polygamum*, *Rubus pubescens*, *Hypericum ellipticum*, *Viola* sp., *Scutellaria lateriflora*, and *Viburnum trilobum*.

5. Hastings County: Mayo Township, near the Little Mississippi River 0.6 km southeast of McArthur's Mills, 45°07' N, 77°34' W. Here, under alders near the foot of a north-facing slope that was covered with hemlock (*Tsuga canadensis*) and fir (*Abies balsamea*), we found a colony of 25 plants (P. M. Catling and R. E. Whiting, TRT). The soil was composed of a black mucky humus (pH 5.3–5.8) and was apparently subject to early spring inundation. The habitat appeared to differ from that of the sawmill stations (4(b) above) chiefly by the presence of a few additional associates: *Thalictrum polygamum*, *Platanthera psycodes*, *Scutellaria lateriflora*, and the moss *Climacium dendroideum*.

These new southern Ontario stations are similar to those we have seen in northern Ontario. At Perry Bay, on the Sibley Peninsula in Thunder Bay District, *L. auriculata* was found in mixed alder and cedar (*Thuja occidentalis*) swampland and was rooted in acid cushions of sphagnum moss and alder litter. Sandy substrate habitats of *L. auriculata* are well known along the Lake Superior shores, in both Ontario and Michigan, and along some of the major rivers draining into the lake (Case 1964a, b; Catling 1976). We have found the auricled twayblade in both humic and sandy substrates, but the soil reaction has always been acid. Alders have always been present, and spring flooding has been evident, sometimes from the

presence of debris caught in the lower branches of the alders.

It is likely that more stations of *L. auriculata* will be discovered in Canada. With its preference for moist, acid, sandy or humic substrates and a cool microclimate, however, it seems unlikely that this species will be found much farther to the south in Ontario.

The auricled twayblade blooms during late June and early July in southern Ontario, and until late July farther north.

We are grateful to the officials of the various herbaria mentioned in Figures 1 and 2, to L. G. Roberts for directing us to the first Maple Leaf site, to S. M. McKay for field assistance in the Bancroft area, and to A. A. Reznicek for critical reading of our script.

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Thermal Selection and Related Behavior in Larval Yellow Perch (*Perca flavescens*)

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Ross, Jay, P. M. Powles, and Michael Berrill. 1977. Thermal selection and related behavior in larval yellow perch (*Perca flavescens*). *Canadian Field-Naturalist* 91(4): 406-410.

Thermal preferenda and behavior of larval yellow perch (*Perca flavescens*) were observed at successive developmental stages in a vertical thermal gradient. Newly hatched larvae acclimated to 20, 23, and 25°C selected 24.3 ± 3.9 , 24.2 ± 4.5 , and 21.7 ± 2.4 °C respectively. Preferenda did not differ significantly with development stage to day 24. Prior to swim bladder inflation, equilibrium required a combination of sinking and locomotory activity. After inflation (7-10 days from hatching at 23°C), vertical position was regulated by bladder control and blundering into warm water was reduced. This maladaptive behavior in response to elevated temperatures (rising to very warm surface layers) is described and discussed.

Key Words: *Perca*, perch, larvae, thermal, temperature, selection, preferenda, shock, behavior.

The increasing rate of appearance of once-through cooling systems for electric power generators has emphasized the need for research dealing with the thermal preferenda and behavior of aquatic organisms. The early life stages of fish have been largely neglected in this respect, though it has been noted that the young of many species have higher preferenda than older individuals (Fry 1937). Lethal effects (LT₅₀s) have been studied for only a few species (see Hokanson and Kleiner 1974; Powles 1974). Work on thermoregulatory behavior (thermal selection) in larvae is almost entirely lacking (but see Evero-

peyzer 1974; Hoagman 1974).

A comparison of the data of F. D. McCracken and S. H. Starckman (1948. Preliminary observations on the preferred temperature of the perch. MS, Ontario Fisheries Research Library, University of Toronto. 4 pp.) for adult yellow perch (*Perca flavescens*) with that of Ferguson (1958) for yearlings, indicates that adults have cooler preferenda. McCauley and Reid (1973) have verified this observation. In his work on yellow perch, Houde (1969) noted that although larvae under 6.5 mm were able to swim actively, only larger individuals exhibited rheotaxis. In this study we

investigate the possibility that behavior in a vertical thermal gradient shows changes similarly related to development. Our results are the first published observations for larval yellow perch.

Our choice of species was further influenced by its value as a food and sport fish and by its almost ubiquitous occurrence in temperate North America. Also, yellow perch spawn littorally and hatch in shallow water close to shore. Exposure to steep thermal gradients similar to those devised in our laboratory are therefore especially likely to be encountered by this species in thermal discharge situations.

Methods

Thermal selection experiments were conducted in a vertical length of clear plexiglass tubing 70 cm tall and 22 cm in diameter. The wall of this tube was horizontally scored into ten 7-cm sections with a mercury thermometer mounted through the wall of each section. Heat was provided by a painted copper coil (5 mm diameter) through which hot tap water could be made to flow from top to bottom. A valve at the bottom permitted introduction of river water from a refrigerated head tank and a similar valve at the top was used to carry away overflow.

Two complete perch egg strands were collected on 13 May 1976 from Clear Lake, near Peterborough, Ontario. Eggs were transported to the laboratory, acclimated to an incubation temperature of 25°C; and aquaria at three different temperatures. One strand had reached an advanced developmental stage (embryos moving, eyes pigmented) when collected. This group (A) was divided into two subsamples: A₁, acclimated to an incubation temperature of 25°C; and A₂, which was allowed to approach room temperature (23°C). These temperatures remained constant ($\pm 0.5^\circ\text{C}$) throughout the experimental period. Mass hatch occurred overnight 14–15 May (29–43 h after collection) for Group A₁ and on 16 May (46–50 h after collection) for group A₂.

The second strand (group B), which were inactive and the eyes unpigmented, were placed in a constant-temperature bath adjusted to 20°C. Mass hatching occurred overnight May 16–17 (78–91 h after collection).

Larvae were fed daily with fresh plankton from the spawning grounds. No attempt was made to estimate or regulate the types and amounts of food provided. Tank hygiene was maintained by siphoning off suspended material daily.

A schedule for the thermal selection experiments is given in Table 1. Group A₂ (23°) was studied throughout its development, until 24 days old, at which time the experiments were terminated because of a shortage of specimens. Experiments with Groups

TABLE 1—Mean and modal temperatures selected by larval yellow perch, *Perca flavescens*, acclimated to different temperatures at various stages after hatching (May 1976, Clear Lake, near Peterborough, Ontario)

Acclimation temp., °C	N	Runs	Perch age	Selected Temp. (°C)		
				Mode	Mean	SD
25 (A ₁)	31	11	12 h	21.0	21.7	2.4
	21	5	25 "	20.5	23.0	3.2
	24	6	39 "	21.0	22.4	2.3
	19	8	60 "	22.5	22.6	3.2
23 (A ₂)	37	7	12 h	24.0	24.2	4.5
	28	8	23 "	24.5	24.1	3.8
	23	7	31 "	22.5	24.3	3.3
	22	9	47 "	25.5	24.2	3.2
	28	6	3 days	23.5	23.5	3.5
	25	7	4 "	22.5	23.5	3.2
	19	9	5 "	24.0	23.7	3.9
	23	8	7 "	21.5	22.9	3.9
	18	5	10 "	23.5	21.7	5.7
	19	6	13 "	21.5	22.7	3.7
	18	9	17 "	25.5	24.4	4.4
20 (B)	23	7	20 "	25.0	24.8	3.9
	21	9	24 "	24.5	24.0	2.8
	29	6	12 h	22.0	24.3	3.9
	24	6	31 "	25.0	24.1	3.1
	27	6	43 "	21.0	22.7	2.9
	24	5	60 "	21.0	22.4	3.3
	25	8	72 "	21.5	22.8	2.7

A₁ and B were continued only for the first 3 days after hatching.

For each "run," the surface of the gradient was brought to a temperature approximately equal ($\pm 1^\circ$) to acclimation temperature and 20 to 30 larvae were introduced. The gradient was then adjusted to provide an adequate range of temperature and 30 min was allowed for familiarization. The temperature profile was recorded to the nearest 0.5°C and the larvae occurring in each cell were enumerated. Larval counts were performed 3 times in succession (top to bottom) for each temperature profile. A number of runs were performed at 5- to 10-min intervals, the position of preferendum changed, and several more runs were performed. This constituted an "experiment."

Data were then integrated to produce a single temperature distribution by summing the cell counts in each run and, assuming a linear gradient between adjacent cells, assigning these sums to each 0.5°C interval represented. This produced a continuous temperature distribution for each run. Data were then summed for the entire experiment and resultant distributions were normalized by calculating the percentage frequencies for each 0.5°C interval represented.

Results

Larval Survival

Mortality in all groups was high (10%) throughout the first 10 days, until we reached a stable level of about 60–100 individuals per 36-L aquarium. With experimental requirements and additional mortality, the supply of larvae was exhausted 24 days after hatching.

Thermal Selection

The tendency to congregate within a particular temperature range was manifested in newly hatched larvae and did not vary significantly throughout development. This condition was maintained from 12 h to 24 days after hatching (Table 1). The mean temperature selected fluctuated quite markedly, e.g., 3.1°C range for Group A₂ and 1.9 and 1.3°C for A₁ and B.

There was no observed effect of acclimation temperature on temperature selected during the first 3 days after hatching.

Behavioral Observations

Until swim bladder inflation occurred between 7 and 10 days after hatching (Group A₂, 23°C), vertical position in the gradient and aquaria was regulated through a matching of upward swimming force (short bursts of rapid tail beating), and passive negative buoyancy (sinking). Larvae maintaining constant depth would therefore normally be slightly inclined with the head directed upwards (Figure 1a). To ascend, larvae increased their angle of inclination (Figure 1b) or accelerated locomotory movements. Both mechanisms were actually observed, separately and in combination. When activity ceased, the greater density relative to water, together with an anterior center of gravity, caused immediate descent with the head directed towards the bottom (Figure 1c). The rate of sinking was about 1.5 cm/s.

The common behavior pattern appearing in all selection experiments prior to inflation of the swim bladder consisted of the following: (1) slow ascent into

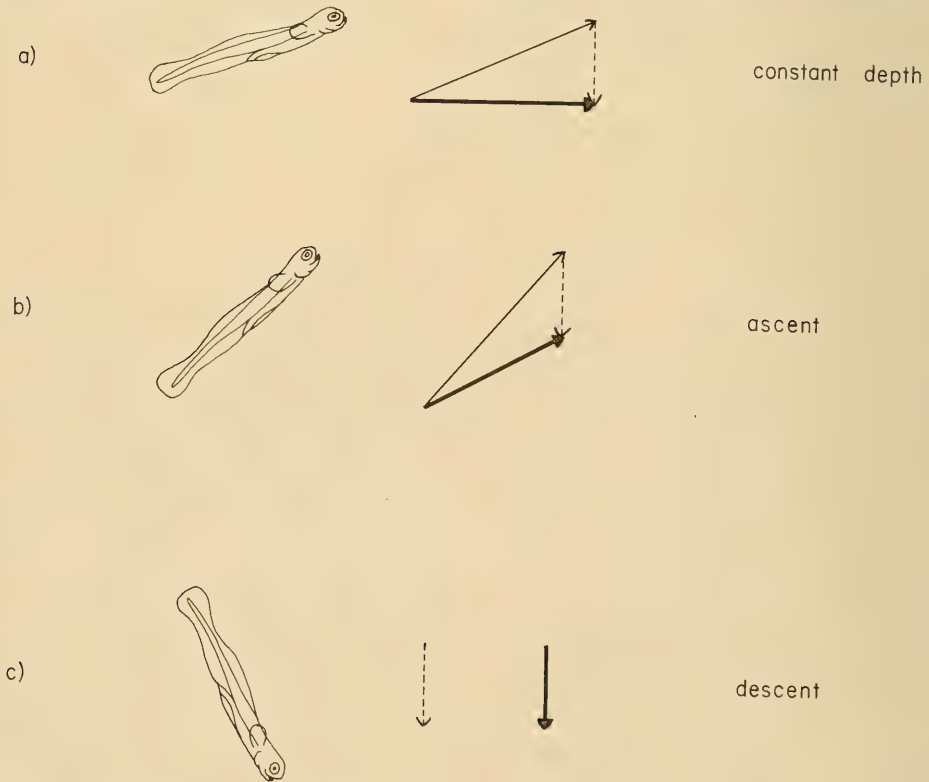


FIGURE 1. Orientations adopted by yellow perch larvae prior to swim bladder inflation. Vectors indicate negative buoyancy (dashed), active propulsion (light solid), and net force (heavy solid).

warmer water, (2) increased activity upon encountering elevated temperatures, (3) very rapid penetration to the surface where the fish swam rapidly in a random path, apparently attached to the surface film, (4) sudden cessation of all activity, causing descent into cooler water, followed by (5) revival, resumption of activity, and re-ascent.

After repeated ascents into very warm water ($> 30^{\circ}\text{C}$), some larvae did not revive and drifted slowly to the bottom remaining there for the duration of the experiment. If the surface of the gradient was extremely warm ($> 40^{\circ}\text{C}$) larvae would become immobilized before reaching the surface.

An interesting side effect of this behavior occurred in larvae from Group A₁ (25°C) which had apparently injected air bubbles. The expansion of gas contained in the gut resulted in a strong positive buoyancy as the fish entered warm water, ultimately resulting in a situation in which the fish lay ventral-side-up on the surface, unable to regain depth.

Coincident with normal inflation of the swim bladder the behavior described above was replaced by one which was more typically adult. That is, vertical position was regulated primarily by bladder buoyancy, swimming being reserved for locomotion. Constant depth could be maintained without activity and, as a consequence, the behavior of larvae in the gradient was less dynamic after swim bladder inflation than before. Fish remained longer in one place (at one temperature). Activity tended to decrease with age, but this observation was not quantitatively substantiated.

Discussion

The most striking feature of our frequency distributions is that they were somewhat broad-shouldered (platykurtotic). The data of McCauley and Read (1973), although not strictly comparable, indicate that much more precise selection occurred in adults and juveniles; under-yearlings captured in October (5 months old) and acclimated to 24°C congregated with some precision (standard deviation -1.8°C) around 23.3°C . The mean standard deviation obtained here was 3.5°C (Table 1). This may be a result of a relative insensitivity of larvae to temperature and may be related to the development of cutaneous temperature receptors or of neural connections, or both.

The lack of any detectable acclimation effect during the first 3 days after hatching may be attributable to the small range of acclimation temperatures represented. The slope of the preferred temperature-acclimation curve from 20° to 25°C for juveniles quoted by Ferguson (1958) was very small; for an acclimation range of 20° to 25°C the corresponding range of preferred temperatures was 23.1 to 24°C

(final preferendum = 24.2°C). These data are in keeping with the present observation, given the lack of precision with which larvae exhibited temperature preference.

The behavior of individual larvae prior to swim bladder inflation must be considered maladaptive in situations where surface temperatures have been artificially elevated by thermal effluents. The tendency to penetrate very hot water and to become immobilized as a consequence, has also been observed in larval lake whitefish (*Coregonus clupeaformis*) by Hoagman (1974). The consistency of this behavior pattern together with its occurrence in at least one other species, suggests that it may have some utility in a natural situation, possibly in response to gentler gradients. The high temperatures encountered in the experimental situation described here may, through overstimulation, trigger some fixed-action pattern which causes larvae to ascend. The frenzy observed in association with this behavior is probably in part an expression of the effects which high temperatures have on biological functions in general, according to the principles of Arrhenius.

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Gestation Period and Juvenile Age at Emergence in Richardson's Ground Squirrel

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Field observations of individually marked animals, and rearing of captive pregnant animals, provided information on time of breeding, length of the gestation period, and age of juveniles at emergence in Richardson's Ground Squirrels. Female squirrels are mated within a couple of days of spring emergence from hibernation, young are born after a 24-day gestation period and first leave the natal burrow 30 days after birth.

Key Words: breeding, ground squirrels, gestation period, hibernation, juvenile emergence, Sciuridae.

Confusion exists in the literature as to the length of the gestation period in Richardson's Ground Squirrel, *Spermophilus richardsonii*. Denniston (1957) estimated gestation to be 17 days, based on an observed copulation of a recently captured female and her subsequent parturition. Asdell (1964) stated gestation to be 28 to 32 days, based on Howell's (1938) report of unpublished data on captive squirrels. Nellis (1969) and Sheppard (1972), quoting Asdell (1964) as their source, assumed a 28-day gestation when calculating conception dates of Richardson's Ground Squirrel embryos. The variation in reported gestation periods suggests that further information is needed before these estimates are used as predictors of time of breeding or time of parturition. Because copulations are rarely seen in the field, and because laboratory breeding is not usually successful, estimates of the gestation period of Richardson's Ground Squirrels are most readily obtained by indirect means. Data collected during studies on the effect of climatic conditions on spring emergence from hibernation and on breeding (Michener 1973, 1977) indicated that the gestation period falls between the 17-day and 28-day estimates. This note elaborates on the data I previously collected, and presents additional data on the length of the gestation period, as well as information on the time of breeding with respect to female emergence from

hibernation, and the age of juveniles at emergence from the natal burrow.

Eight, 31, 23, and 16 female Richardson's Ground Squirrels were live-trapped in mid-April of 1969, 1970, 1971, and 1972, respectively, in southern Saskatchewan. Most of these squirrels (60 of 78) were collected within a 320-ha prairie pasture near Kayville, Saskatchewan (49°40'N, 105°10'W, elevation 780 m). The squirrels were individually caged. Details on caging and diet can be found in Michener (1971). Each animal was checked daily and litters were recorded as being born on the day on which they were first observed. Sixty-five of the females produced litters; of these 38 had been captive for 17 or fewer days and 27 for more than 17 days (Table 1). Thus 42% of the females had been held captive, separated from males, for longer than the 17-day estimate of the gestation period made by Denniston (1957). Since Denniston observed copulation between his captive female and a male, and since the weights reported for the young of this female indicate that the litter was not premature, the female was presumably pregnant at capture and the mating was aberrant behavior associated with the stress of captivity. Two of my squirrels gave birth after 23 days in captivity (Table 1), and this period is taken as a minimum estimate of the gestation period. These data do not allow a maximum estimate of the

TABLE 1—Frequency distribution of the number of days in captivity prior to parturition, and of the number of days between earliest possible spring emergence and parturition

	Number of days															N
	<17	17	18	19	20	21	22	23	24	25	26	27	28	29	>29	
Capture to parturition	36	2	10	—	7	5	3	2								65
Emergence to parturition										9	1	1	5	—	16	

gestation period to be made since it was not known how many days prior to capture that females had been mated.

Field observations of Richardson's Ground Squirrels on a 1-ha portion of grassland near Longview, Alberta (50°34'N, 114°18'W, elevation 1235 m) provided information on the maximum length of the gestation period. Details of the study area are in Michener (1977). In 1975 all adults and juveniles on the area were tagged with a numbered metal tag in each ear, and individually marked by a combination of black dye on the fur and a colored plastic disc attached to one ear tag. In 1976 and 1977 the area was trapped and observed at 1- to 6-day intervals in late March and April until no new residents appeared; all females that emerged in the spring had been tagged in previous years. In 1976, 11 of the 14 resident females, and in 1977, all of the 12 resident females emerged after the first trapping episode of the year, so that their date of spring emergence was known to within an interval of several days. For each of these females the earliest possible date of emergence was taken as the first day of the interval between her last observed absence and her first observed presence in the active population. Trapping at 3- to 4-day intervals combined with observation on extent of uterine swelling and condition of the nipples allowed the date of birth to be determined to within ± 1 day for 18 litters born to 15 females in the 2 years. The interval between earliest possible day of spring emergence and the date of parturition, which could be calculated for 16 litters, provided an estimate of the breeding plus gestation time (Table 1). Nine litters were born 26 days after the earliest possible emergence of the mothers. Assuming that these females were bred immediately on emergence from hibernation, the maximum possible gestation period is 26 days. Just as the laboratory data tend to underestimate the gestation period, since females were bred an unknown number of days prior to capture, the field data tend to overestimate it since females could have emerged on any day in the several-day interval between absence and presence in the

observed active population, and, once emerged, females were probably not immediately mated. The combination of the two types of data narrow the estimate of the gestation period to between 23 and 26 days. Allowing for the respective underestimates and overestimates involved suggests that 24 days is the best estimate for the gestation period. Individual variation of ± 1 day may occur, especially between squirrels from different altitudes (as in this study) or latitudes. Since Howell (1938), in reporting the unpublished work of another person, provided no information on the sample size or methods used to obtain the 28- to 32-day estimate of gestation, it is not possible to account for the discrepancy between that estimate and my estimate of 24 days.

Estimates of the length of the gestation period, usually based on occasional instances of breeding in captivity and subsequent parturition, are available for other species of Canadian ground squirrels. Shaw (1925) reported a 24-day gestation period for Columbian Ground Squirrels (*S. columbianus*), a species which is sympatric with Richardson's Ground Squirrels in the foothills of the Rocky Mountains, the eastern and western limits of their respective ranges. Thirteen-lined Ground Squirrels (*S. tridecemlineatus*), which are also sympatric with Richardson's Ground Squirrels over much of their range, have a gestation period of 27 to 28 days (Wade 1927; Johnson and Wade 1931). Golden-mantled Ground Squirrels (*S. lateralis*) have a 27- to 28-day gestation (Cameron 1967) and Arctic Ground Squirrels (*S. undulatus*) a 25-day gestation (Mayer and Roche 1954). No reliable estimate of the gestation period is available for Franklin's Ground Squirrels (*S. franklinii*).

In some species of marmots in which animals of both sexes share a hibernation den through the winter, breeding has been reported to occur in the den prior to spring emergence (Rausch and Rausch 1971). In Richardson's Ground Squirrels, adult males leave the active population and enter the hibernation phase of the annual cycle up to 8 weeks before adult females, and juvenile males 2 weeks after juvenile females; all

males emerge several weeks earlier than females the following spring and are, therefore, already active when females begin leaving their hibernation burrows (Michener 1977). Retrapping of females in early spring indicated that enlargement of the vulva, assumed to be an indicator of estrus, occurred after female emergence from hibernation. Occasional instances of copulation (Quanstrom 1971) and of pre-copulatory behavior (Clark and Denniston 1970) have been observed in the field in spring. Thus, hibernation in a common den and pre-emergence mating does not occur in *S. richardsonii*. On the basis of a 24-day gestation period, Table 1 indicates that female squirrels were in the active population no more than 5 days before being mated. Because of the several-day range over which spring emergence could have occurred, it is most likely that mating usually occurred about 2 days after entry into the active population. Capture of squirrels during the interval between spring emergence and breeding may in part account for the failure of 13 of the 78 Saskatchewan females to produce litters in the laboratory.

During the time of juvenile emergence from the natal burrow, the area was observed at 1- to 5-day intervals. Of the 14 females in 1976 and 9 females in 1977 that gave birth, 12 and 7 respectively reared pups to weaning age. For 17 of these litters, date of birth and date of entry into the above-ground population were known, allowing the age of the juveniles on emergence from the natal burrow to be estimated (Table 2). Pups were at least 4 weeks old when they first left the burrow; from Table 2 the average age (\pm standard deviation) at emergence is 31 ± 2 days. Because of the several-day interval between searches for emerged litters, some juveniles could have been in the active population for 2 to 3 days prior to their first sighting in the population. Thirty days is taken as the best estimate for juvenile age at emergence. Inclement weather appears to delay juvenile emergence, and members of small litters sometimes emerge 1 or 2 days earlier than usual.

TABLE 2—Frequency distribution of the number of days between birth and first above-ground sighting of litters reared in 1976 and 1977

Number of days										
28	29	30	31	32	33	34	35	>35	N	
—	1	9	2	—	4	—	1	—	17	

To determine whether the 24- and 30-day periods are good estimates of gestation and weaning periods respectively, these periods were used to predict the date of breeding for four females for which no accurate parturition date was available but for which

litter emergence dates were known. In each case the resultant date fell within the period in which the female was known to have entered the active population. Similarly, using these periods for females resident in 1975 gives breeding dates between 18 and 26 April; it was known that no females had emerged before 14 April that year (Michener 1977). Assuming females to have been active 2 days prior to mating, the date of spring emergence can be estimated; in all cases the emergence date falls no earlier than the earliest possible emergence date based on the female's absence and subsequent presence in the active population.

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A Second Population of Rock Voles, *Microtus chrotorrhinus*, in Minnesota with Comments on Habitat

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The rock vole, *Microtus chrotorrhinus*, has been reported in Minnesota from a single specimen taken near Burntside Lake, St. Louis County in 1921 (Swanson 1945; Handley 1954) and from 26 specimens taken at one locality along the Gunflint Trail in central Cook County (Timm 1974; Timm et al. 1977). In recent years, subsequent collecting in the Burntside Lake area by several different individuals has failed to reveal additional rock voles.

Four rock voles were captured along the south shore of Saganaga Lake in northern Minnesota during a study of the impact of the Roy Lake wildfire on small mammal populations (Buech et al., unpublished data). This find is significant because it is the western-most population currently known for the species, it identifies a second viable population of rock voles in Minnesota, and it provides additional insight into the habitat requirements of this rare vole.

The rock voles were captured near Red Rock Bay of Saganaga Lake, 74 km north and 6 km west of Schroeder (SW 1/4 of the NE 1/4 and SE 1/4 of the NW 1/4 section 27, T. 66 N, R. 5 W, elevation 440-460 m) in the northwestern tip of Cook County, Minnesota. This site is located 21 km north and 47 km west of the Gunflint Trail population and some 27 km north and 80 km east of Burntside Lake. The four rock voles were captured within 30-180 m of each other on 2 and 3 September 1976 in a spruce-fir-aspen community in which portions of the overstory appeared to have been removed by wind.

Three of the rock voles captured were males, one a female. The largest, an adult male (weight 42.0 g; testes 7×4 mm), was undergoing extensive autumnal molt. One subadult male (testes = 4×2 mm), undergoing molt into the adult pelage, was partially consumed by a shrew. A second subadult male (weight 22.4 g, testes = 3×2 mm) was not molting. The female (weight 28.4 g) was molting into the adult pelage and exhibited no evidence of previous reproductive activity (no embryos or placental scars present in the uterus and all ovarian follicles minute). One species of chigger, *Neotrombicula microti*, was found parasitizing all four rock voles. The rock voles have been deposited in the mammal collection of the James Ford Bell Museum of Natural History, University of Minnesota, Minneapolis, Minnesota. For more details concerning the mammalian fauna of this region see Timm (1975).

Estimates of habitat attributes were available at three of the four capture sites. A sparse overstory of trees, a dense tall shrub stratum, and a sparse low shrub-herbaceous stratum were characteristic of the three sites. Two of the sites were located below a boulder escarpment between upland forest dominated by shrubs and lowland forest dominated by black spruce (*Picea mariana*). The overstory at these two sites had 5 and 9 m² basal area (BA)/ha, respectively, in black spruce about 14 cm diameter breast height (DBH), and 3 m² BA/ha each in white birch (*Betula papyrifera*) or quaking aspen (*Populus tremuloides*).

both about 25 cm DBH. The third site was located on a slope below an upland shrub community and differed in that there were no rocks present. Here the overstory contained only 3 m² BA/ha in white birch and quaking aspen combined. The tall shrub layer on all three sites included round-leaved dogwood (*Cornus rugosa*), beaked hazel (*Corylus cornuta*), red maple (*Acer rubrum*), balsam fir (*Abies balsamea*), and white birch. Other species noted in the low shrub-herbaceous layer included prickly rose (*Rosa acicularis*), currant (*Ribes*), raspberry (*Rubus*), bush honeysuckle (*Diervilla lonicera*), blueberry (*Vaccinium angustifolium*), twin-flower (*Linnaea borealis*), bunchberry (*Cornus canadensis*), Clinton's lily (*Clintonia borealis*), large-leaved northern aster (*Aster macrophyllus*), wild sarsaparilla (*Aralia nudicaulis*), and sphagnum moss (*Sphagnum*). Organic litter and deadwood were abundant on the three sites.

The habitat composition and structure of these capture sites were similar to those described by Timm et al. (1977) for rock voles in central Cook County. The composition of the tree overstory in both areas was similar, but density was greater at the Gunflint Trail site. Rock voles there, however, were restricted to a narrow transition zone dominated by shrubs, between the boulder stream and the forest. Shrubs were likewise dominant at Saganaga Lake, although there the shrubs were a result of a sparse overstory. Both the Gunflint Trail and Saganaga Lake areas had a generally sparse herbaceous layer composed of many of the same species; however, the Saganaga Lake site was not located near an open boulder field. Although two of the capture sites were near a boulder escarpment, one site had no rocks in the vicinity.

Rock voles have been reported from moist rocky habitats in Canadian and Hudsonian life zones (Timm et al. 1977) and rarely in small openings in moist forests (Goodwin 1929). Most previous accounts of rock vole habitat stressed the importance of rocks, boulders, or talus as an important component (Gunderson and Beer 1953; Burt 1957; Linzey and Linzey 1971; Martin 1971; Doult et al. 1973; Timm et al. 1977). In contrast, Kirkland (1977) found 50 of 73 rock voles in clearcuts less than 8 years old in West Virginia. Moreover, the voles were twice as abundant in red spruce (*Picea rubens*) and red spruce-deciduous clearcuts (less than 3 years old) than in adjacent uncut stands. This led Kirkland (1977) to suggest that rock voles exploited disturbed sites and benefited from forest openings created by clear-cutting practices.

The vegetation composition and density where rock voles have been collected along the Gunflint Trail, at Saganaga Lake, and those described in the literature are similar. Rocks or rocky escarpments may not be the most crucial component of rock vole habitat. The

vegetation characteristics of younger communities, including a relatively open overstory, a high density of shrubs, and thick moist litter, may be equally if not more important. This habitat type is often associated with proximity to boulder fields or talus slopes, but it may also be created by logging (see Goodwin 1929; Kirkland 1977) or by wind falls. If thick moist litter is truly a dominant requirement, fire may rarely if ever create favorable habitat for rock voles because it usually destroys the litter layer. The fact that most forest stands in this region are of fire origin could in part explain the apparent scarcity of rock voles.

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Occurrence of the Slimy Sculpin, *Cottus cognatus*, in the Missouri Drainage System

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On 1 July 1976 three specimens of the cottid, *Cottus cognatus*, were collected by the author from the North Milk River approximately 10.8 km north-northeast of Del Bonita, Alberta (49°07'N, 112°44' W). These specimens, number 3842 in the University of Alberta Museum of Zoology (UAMZ), represent the first recorded occurrence of the Slimy Sculpin in the Missouri River drainage system. Willock (1969) and Henderson and Peter (1969) reported the Mottled Sculpin, *Cottus bairdi*, from the Milk drainage. One specimen of the Spoonhead Sculpin, *Cottus ricei* (UAMZ 454), has also been recorded from the Milk River system (Paetz and Nelson 1970).

The Slimy Sculpin is widespread in North America, occurring from Alaska to New Brunswick with southern extensions into British Columbia and Virginia (Scott and Crossman 1973). Paetz and Nelson (1970) record the Slimy Sculpin from the Petitot, Hay, Slave, Peace, Athabasca, and Beaver drainages of Alberta. They felt an early record from the Red Deer drainage was questionable. McCart and Jones (1975) list *C. cognatus* as common in the Red

Deer and Raven Rivers, but unfortunately the specimens were not saved. Wayne Roberts (UAMZ, personal communication, 1976), studying sculpin in the Red Deer system, reports only *C. ricei*.

The occurrence of the Slimy Sculpin in the headwaters of the Milk River would represent a considerable southward or westward range extension. This species, however, occurs west of the Rocky Mountains in the headwaters of the Columbia River system. This seems to be the most likely source of the Milk River population. McAllister and Lindsey (1961) have been able to distinguish several populations of Slimy Sculpin on morphological grounds. The northwestern form is usually characterized by four pelvic fin rays and a branched last anal fin ray. The southeastern form typically has three pelvic fin rays and an unbranched last anal fin ray, while a British Columbia form (Peace and Columbia River systems) is intermediate in both characters. The occurrence of the branching of the last anal fin ray in two of the three Milk River specimens as well as the reduced or absent fourth pelvic fin ray (Table 1) seem to support a Columbia River system origin.

TABLE 1—Meristic and morphometric data for three Slimy Sculpin, *Cottus cognatus*, from the Milk River, Alberta

	Specimen number		
	1	2	3
Standard length (mm)	41.8	38.0	44.0
Head length (mm)	12.2	11.0	13.3
Orbit diameter (mm)	3.1	3.0	3.2
Postorbital distance (mm)	5.9	5.4	6.4
Maxillary length (mm)	5.4	4.5	6.0
Caudal peduncle length (mm)	7.7	7.0	8.6
Caudal peduncle depth (mm)	3.1	2.6	3.2
Pelvic fin ray count (left/right)*	3½/3½	3/3½	3¼/3¾
Anal fin ray count**	12½	12½	12
1st dorsal fin ray count	8	8	8
2nd dorsal fin ray count**	16½	16½	17½
Pectoral fin ray count	13	14	13
Median chin pores	2	2	2
Lateral line pores	≈ 20	≈ 19	≈ 18
Lateral line ending under 2nd dorsal fin ray number:	12	8	10

*Fraction represents proportion of last ray to next-to-last ray.

**½ indicates branched last ray.

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Usage of the Terms "Cannibalism" and "Scavenging" in Ecological Literature

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Recently Thompson (1976) described the accidental death of a young Gray Squirrel (*Sciurus carolinensis*) and subsequent eating of the dead animal by the mother squirrel. He used the term "cannibalization" for the latter act. In contrast, Fisher (1974, 1975a, b) discussed in some detail his reasons for believing the eating of one adult Great Gray Owl (*Strix nebulosa*) by another was an act of cannibalism rather than the scavenging of an already dead bird.

These papers and others use the term "cannibalism" and variants of it in two senses: (1) the eating of the flesh of one's own species dead or alive; and (2) the killing and subsequent eating of a member of one's own species. The selective pressures for eating an already dead animal may be substantially different from those involved in killing another animal of the same species, especially kin, and then eating it. The latter act may be important in carnivorous species in times of food shortage, whereas the former may be merely an opportunistic act of scavenging. Thus, although a Webster dictionary definition of "cannibalism" corresponds to my first definition, I believe it would be more instructive to use the more restricted (second) definition in ecological literature, and use the term "scavenging" for cases of an animal's eating already dead members of its own species. This duality of meanings also occurs in accounts in the popular press of the eating of human flesh by humans (*Homo*

sapiens), with the selective pressures for hunting of humans strong in some primitive societies and for eating dead humans strong in certain cases of extreme hardship, such as airplane crashes in remote areas. The latter situation is, of course, complicated by ethical considerations.

Finally, as observations distinguishing these behaviors are rarely obtained, I reiterate an earlier plea (McNicholl 1976) for more publications of the carefully documented sort well exemplified by Thompson's note.

A. J. Erskine provided useful comments on the manuscript.

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Manipulative Behavior by a Red Squirrel

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I encountered an interesting case of live-trap manipulation, perhaps by an individual Red Squirrel, *Tamiasciurus hudsonicus*. This species is common in both White Spruce (*Picea glauca*) and Black Spruce (*Picea mariana*) forests of interior Alaska. The following observations were made from June 1972 to July 1974 in Black Spruce forest at the edge of the 1971 Wickersham Dome forest fire 60 km north of Fairbanks, Alaska. At this site the colonization of the burned area by Northern Red-backed Voles (*Clethrionomys rutilus*) and Tundra Voles (*Microtus oeconomus*) was investigated by means of two live-trapping grids, one in the burned area and the other in unburned forest 50 m away. Each grid contained 96 Sherman large ($7.6 \times 8.9 \times 22.9$ cm) folding aluminum traps.

Trapping on these areas was initiated on 2 June 1972, and on 18 June I found one trap on the unburned area that had been dismantled by the removal of one of the two wires joining the trap hinges (Figure 1). The wire was found next to the trap and the trap remained in its proper position on the grid. During subsequent trapping periods through 22 October, a total of 360 traps were found dismantled in the unburned area and 141 in the burned area. Typically the top hinge wire was pulled out; however, if it was bent or jammed the bottom wire was removed. Rolled oats, used as bait, was missing from about half of the dismantled traps. Fortunately, the traps were dismantled during the day and interference with the trapping of voles was negligible because voles were trapped only at night.

There were two Red Squirrel middens near the



FIGURE 1. Sherman live-trap dismantled by a Red Squirrel. Hinge wire visible in foreground has been pulled from the upper hinge of the trap.

trapping grid in the unburned area, one roughly 50 m north and the other about 60 m south of the grid. Both middens have been inhabited continuously since the fall of 1971. As there was little pattern in the dismantling of the traps, at that time it was not clear whether one or both squirrels were responsible. Squirrels were often seen running from the traps, but were never observed pulling out the wires.

During the winter of 1972–73 no traps were dismantled, although the squirrels were active on nearly all days when the temperature was higher than about -30°C (Dice 1921). The traps were operated at ground level in holes cleared of snow by hand. In this position the traps were probably too inaccessible for dismantling. Additionally, contact with the traps was undoubtedly reduced in winter, since Red Squirrels spend a greater proportion of time at the middens during this season (Pruitt and Lucier 1958). On 13 April 1973, while some snow remained, I found 12 dismantled traps in the unburned area. Thereafter the pattern continued as in the previous year, resulting in 373 dismantled traps in the unburned area and 83 in the burned area. I did not trap in the fall or winter of 1973, but resumed on 19 May 1974 and found 48 dismantled traps in the unburned area on 20 May.

The usual pattern of trap dismantling continued until 24 June 1974 when a trap was dismantled during the evening trapping period, even though the traps were open. Since this behavior was incompatible with the trapping of voles, I decided to remove the offending squirrel or squirrels. By 18 July I had shot one squirrel and by live-trapping had taken 15 others from the middens and relocated them in Black Spruce

forest 5 to 8 km away. Most of these animals were young of the year. As the squirrels were taken from only two middens, it is apparent that considerable pressure by supernumerary individuals exists for the possession of these sites (Smith 1965). In spite of these removals the dismantling continued, and 31 traps were dismantled during the trapping period of 18–19 July.

On 19 July I saw an adult female squirrel in the unburned area and subsequently shot it at the midden north of the trapping grid. A young squirrel occupied the midden by evening. Live-trapping continued on these grids, but after the adult female was removed, no more traps were dismantled. It is probable that this individual was responsible for dismantling every trap over the 2-yr period. The total number of dismantled traps was 1074 in the unburned area and 384 in the burned area. Surprisingly, only two hinge wires were lost. To date I have not heard of such Red Squirrel behavior occurring elsewhere.

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Harassment of an Elk Calf by Bison

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At 1733 hours CST, 9 June 1975, during fieldwork at Fort Niobrara National Wildlife Refuge, Valentine, Nebraska, I noticed a disturbance and much movement among a herd of approximately 60 bison (*Bison bison*) including four mature bulls in a 2-ha area. Many of the individuals held their tails vertically, indicating a high degree of excitement (Shult, M. J. 1972. American bison behavior patterns at Wind Cave National Park. Ph.D. thesis, Iowa State University, Ames. 178 pp.). A cow with her tail held in this position ran from a second herd grazing 200 m to the south to join the first group soon after the disturbance began.

When I approached in my vehicle to within 20 m, I saw a young spotted elk calf (*Cervus elaphus*) among the bison. Some individuals smelled it, several butted heads with or tried to mount other individuals, while a few sexually investigated the cows in the group and exhibited flehmen¹. Some frolicked and kicked their hind legs in a playful manner. Members of the group

¹Posture exhibited by most ungulates, usually males, after scenting a female's vulva, urine, or other odor. The individual tilts its chin upward and exposes the upper gums by drawing back its upper lip. See figure 13-3 in Gunderson, H. L. 1976. *Mammalogy*. McGraw-Hill, New York. 483 pp.

moved constantly as they crowded closely around the calf. Several times, after smelling the calf, individuals were displaced by others and stepped over it. One yearling licked the calf's hindquarters and nudged it with its nose. At times as many as five bison smelled the calf simultaneously.

Initially, the elk dam was grazing 100 m east of the calf. After the bison surrounded the calf, she repeatedly approached but was chased away by two or three young bull bison and on one occasion, by a cow, all holding their tails vertically.

At 1738 hours the elk calf stood up and walked wobbly-legged toward my position. It came within 3 m of the vehicle and then circled it to the other side. During this 16-s movement, it was followed by the entire group of bison, led by two mature bulls, several cows, and young bulls. One of the mature bulls lowered its head and butted the calf to the ground, causing it to bleat. Other bulls immediately behind the first also lowered their heads and attempted to butt and hook the calf with their horns. Their attempts failed, but two did hook the ground next to the calf, throwing chunks of sod into the air. At this point, I jumped out of the vehicle and began honking the jeep's horn and shouting to frighten the bison away.

Within the group there was still a lot of movement, with several individuals butting heads and frolicking, and from the southwest additional individuals joined the group. The calf remained on the ground, and we

were surrounded by more than 60 bison. Finally, I drove to the elk calf, placed it in my jeep, and drove 20 m north of the bison. Here I waited until 1800 hours while their activity gradually subsided and they moved to the southeast. I then returned the calf to its original position. At 1828 hours the elk dam approached her calf and it followed her to the southwest.

Two incidences of harassment of elk calves by bison were reported to Shult (*op. cit.*) during his work at Wind Cave National Park. These included brief, but similar, descriptions of movement and excitement among the bison around the elk calf. In both cases the calves were unharmed.

Reasons for such attacks and excitability among bison may be a reaction to a strange odor and the proximity of other bison as they crowd together to investigate that odor. Many times I have seen domestic cattle similarly crowd together in an attempt to investigate a dog. During these incidences the cattle appeared highly excited and even chased the dog. During the fall 1975 roundup at Fort Niobrara, I observed an increase in the number of displacements and head butting as the individuals were crowded into a corral. These latter activities, however, are considered agonistic and do not explain the playful nature of some of the behavior observed around the elk calf.

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Movements of Nuisance Black Bears (*Ursus americanus*) in Southeastern British Columbia

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The existence of poorly managed garbage dumps in southeastern British Columbia has created problems for both humans and black bears (*Ursus americanus*). A total of 236 nuisance bears were tagged between June 1968 and October 1973. Data from recaptures and resightings of tagged bears indicate a high mobility for some bears. Several bears returned to the original capture location one or more times. Some bears returned over 80 km (straight-line distance) to the capture location.

Key Words: black bears, *Ursus americanus*, garbage dumps, British Columbia.

In the 12 years following establishment of large community garbage dumps, black bears in urban and suburban areas of southeastern British Columbia have come increasingly into conflict with man. In an effort towards better management, nuisance bears

were live-trapped, tagged and released at a considerable distance from populated areas. Although the program was carried out principally to remove problem bears, the results provide information on population structure and mobility, including the

capacity of British Columbia black bears to return to areas from which they have been removed. The study area consists of approximately 922 km², centered around the City of Nelson (49° N, 117° W), British Columbia.

Background and Methods

Trapping, immobilizing, and tagging techniques have been described in the literature and by Rutherglen (1973. The control of problem Black Bears. Wildlife Management Report 11, British Columbia Fish and Wildlife Branch. 26 pp.). Between June 1968 and October 1973, 236 bears were tagged. Sex, general condition, visual estimation of age based on tooth characteristics, and approximate weight were recorded for each bear tagged. Where possible, additional data were recorded on subsequent positive sightings or recaptures.

Releases were made from 16 to 112 km from capture locations and 23 different release sites were used. Most release sites provided an abundance of forage for bears and available drinking water.

Results and Discussion

The 236 bears tagged do not represent a random selection of animals from the Nelson District, but only bears that became problems in association with people. The greatest number of bear "complaints"

TABLE 1—Nature of complaints from public, which lead to handling and tagging of bears

Type of complaint	1968	1969	1970	1971	1972	1973
Garbage	32	11	19	50	76	39
Farm produce	13	3	6	10	13	9
Slaughter pit*	10	3	—	—	—	—
Other (or unrecorded)	2	2	—	11	4	—
Total	57	19	25	71	93	48

*This slaughter pit was not in use after 1969.

TABLE 2—Numbers, sex, age and recaptures of 236 bears tagged over a 6-yr period

Year	Bears tagged				Bears recaptured or resighted		
	Total	♂/♀	Age in years		Tagged in same year	Tagged in previous year	♂/♀
			≤ 2	≥ 2			
1968	46	32/14	15	31	11	—	8/3
1969	12	9/3	3	9	—	7	6/1
1970	18	13/5	5	13	5	2	6/1
1971	53	31/22	14	39	12	6	7/11
1972	75	53/22	19	56	8	10	11/7
1973	32	20/12	9	23	4	12	14/2

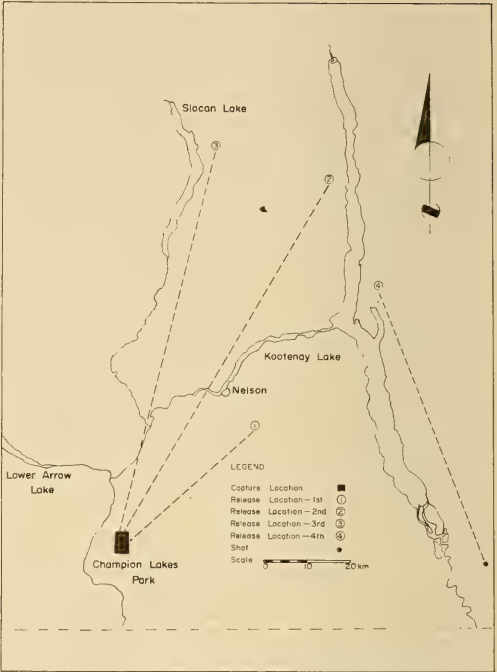


FIGURE 1. Movements of Bear Number 228.

were related to garbage (Table 1), particularly in the vicinity of community garbage dumps.

Most of the bears appeared to be in good or fair physical condition upon capture. There were consistently a larger number of males tagged each year than females and fewer sub-adults than adults (Table 2).

In similar mountain habitat in northwestern North America, Jonkel and Cowan (1971. The Black Bear in the spruce fir forest. *Journal of Wildlife Management* 27: 1-57) found that normally only those black bears

with home ranges adjacent to special feeding areas make use of such sites. They suggest a possible smaller home-range size for sub-adults than for adults and a greater mobility for males than for female bears. This could explain the low numbers of females and sub-adults in our study.

The number of bears tagged varied considerably from year to year, ranging from 12 in 1969 to 75 in 1972 (Table 2). Some inconsistency in capture effort must be recognized; the low numbers of bears tagged in 1969 and 1970 coincide with relatively few complaints in those years. The variation in spring weather and its effect on plant development is believed to be partially responsible for these fluctuations. This statement is based on the annual observations of the senior author over a period of 28 years.

There were 77 recaptures or confirmed resightings made, involving a total of 54 bears. These previously marked bears consisted largely of adults, most in apparently normal condition, again with a higher proportion of males than females (except in 1971) (Table 2).

Factors influencing the incidence of return remain unclear. Preliminary data suggest that release during May resulted in the highest proportion of returns. This may be because the choice of good release sites in

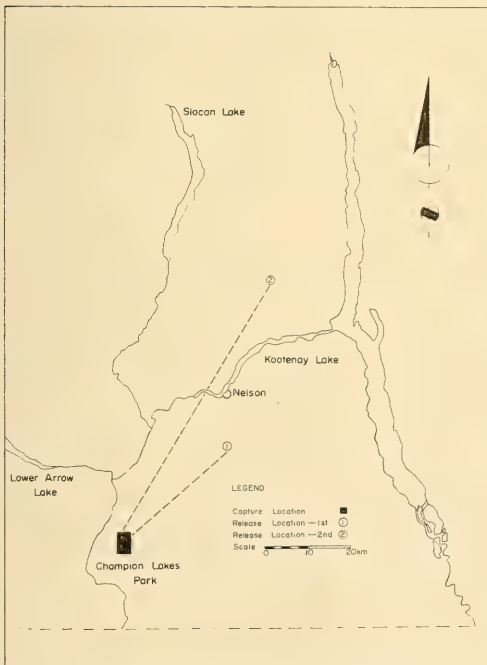


FIGURE 2. Movements of Bear Number 19.

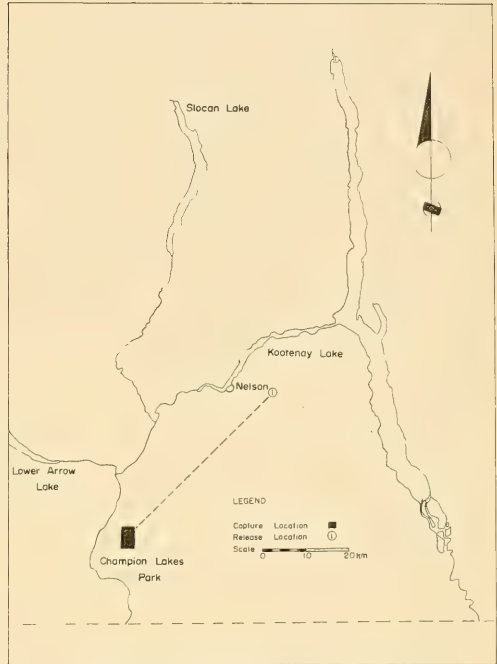


FIGURE 3. Movements of Bear Number 478.

May is limited, forage at a sufficient distance from low-elevation populated areas is scarce, and the transport of bears to high elevations is blocked by snow or washed-out roads. Recaptures of bears released in October were normally made the following year. Experience indicates that cubs left behind and good feeding areas act as the strongest incentives for bears to return, although this is difficult to demonstrate from the data.

Bears were found to have travelled distances ranging from 10 to 99 map-km (straight-line distance), at rates of up to 11 km per day. In some instances, the apparent rate of travel was much slower. The topography was generally mountainous and rugged and this may have influenced the rate and direction of return for certain individuals. Bears were found to have crossed bodies of water approximately 1 km wide, but observations of three tagged bears indicate a tendency for the animals to walk around Kootenay Lake, which measures approximately 5 km across.

Thirty-seven bears out of 54 were recaptured at their original capture location, nine of them making two or more returns from a variety of release sites. Distances travelled and rates of return varied greatly. Some bears were recaptured at the original capture location as long as one year after release and may have

returned to the capture site at once. Ten bears, however, made their returns to original capture locations within one month of release.

Bear Number 228, a female with cubs, was originally captured on 7 July 1971 at Champion Lake Park (Figure 1). She and one cub were moved; the second cub was destroyed. From a release location 38 km away at Clearwater Creek, this adult and her cub returned to Champion Lake Park. They were recaptured on 15 July 1971 and released 88 km away at Fletcher Creek. On 3 June 1972 this female was recaptured for the third time in the park and released 99 km away at Retallack. On 11 June 1972 she was back at the park for a fourth time. This time she was released across Kootenay Lake at Crawford Creek, 88 km away. On 15 June 1972 she was shot at Arrow Creek and it is possible that she was in the process of returning once more.

Bear number 19 returned to the original capture location (a slaughter pit) following two different releases. The first return was a trip of approximately 22 air-km, the second, more than 56 km, was accomplished in 7 days (See Figure 2).

Bear number 478 illustrates that the return to

original capture location is not necessarily simply a return to the nearest source of garbage. This bear was released within 8 km of the garbage dump at Nelson, but was recaptured at its original capture site more than 32 km from Nelson (See Figure 3).

The data indicate that dump use is not dependent on simple random movement. If we consider bear mobility and the extensive capability of bears to return home, open garbage dumps pose a serious game management problem.

Acknowledgments

We are most grateful to Gordon Hartman for his encouragement and advice during preparation and finalization of the paper, and to Anne I. Dagg for her assistance with the early stages of the original manuscript. We appreciate the work of Timothy Rutherglen, who provided information and assistance during 1972 and Peni Campbell, who worked on the figures. Dubious thanks should go to the communities of the West Kootenay that have provided garbage dumps and the garbage bear problem.

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Paspalum ciliatifolium, a Grass New to Canada from Southwestern Ontario

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Crins, W. J., P. D. Pratt, and D. F. Brunton. 1977. *Paspalum ciliatifolium*, a grass new to Canada from southwestern Ontario. Canadian Field-Naturalist 91(4): 422-424

The grass, *Paspalum ciliatifolium* Michx., is reported as a new addition to the flora of Ontario and Canada. The original discovery was made in Essex County in 1975, with two additional stations being found in Kent County in 1976. The ecology and taxonomy of the species are discussed and it is suggested that *P. ciliatifolium* will likely be found elsewhere in southwestern Ontario.

Key Words: *Paspalum ciliatifolium*, new to Canada, Ontario, distribution, grass.

On 31 August 1975, the authors discovered a large station of the grass, *Paspalum ciliatifolium* Michx., at Windsor, Essex County, Ontario. Subsequently, on 18 September 1976, in adjacent Kent County, P.M. Catling, A. A. Reznicek, R. Brown, and S. M. McKay located two additional stations of the species (see Figure 1). The genus *Paspalum* is not listed by Soper (1949) nor by Boivin (1967), and examinations of various herbaria (including CAN, DAO, OAC, and TRT) have turned up no records. As we could find no

evidence of its previous occurrence in the country, we conclude that the Essex County station constitutes the first record of any member of the genus, not only within Ontario, but from anywhere in Canada.

Taxonomy

The species here referred to as *P. ciliatifolium* Michx. has been the subject of differing taxonomic interpretation. In view of the fact that the material has been identified at the varietal level, a brief discussion

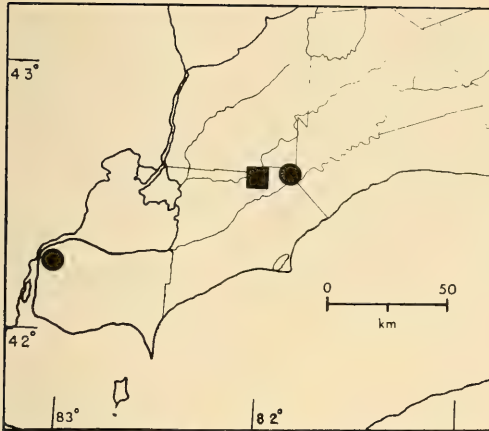


FIGURE 1. Distribution of *Paspalum ciliatifolium* var. *muhlenbergii* (●) and *Paspalum ciliatifolium* var. *stramineum* (■) in Ontario.

of these taxa is appropriate. Several early works dealing with the genus *Paspalum* have considered *P. ciliatifolium* to consist of three separate species (Nash 1912; Rydberg 1932; Hitchcock and Chase 1950). Gleason (1952), however, recognizes a single species, *P. ciliatifolium*, composed of three varieties corresponding to the three species of earlier authors. It is Gleason's interpretation that we are following. Voss (1972) indicates the presence of two varieties of *P. ciliatifolium* in Michigan, *P. ciliatifolium* var. *muhlenbergii* (Nash) Fern. and *P. ciliatifolium* var. *stramineum* (Nash) Fern. Both of these varieties have been found in the Ontario collections described here.

Species Range

In the broad sense, *P. ciliatifolium* is a widely distributed species of the United States (Hitchcock and Chase 1950; Gleason 1952). The American range is described by Gleason (1952) as extending from New Hampshire and Massachusetts, west to Michigan, Minnesota, Kansas, and Arizona, and south to the Gulf of Mexico. *Paspalum ciliatifolium* var. *muhlenbergii* is found throughout much of this range, but *P. ciliatifolium* var. *stramineum* tends to occur in the western part of the range, being considered a species of the prairies and plains (Rydberg 1932).

The first Canadian station, in Essex County, was revisited on 16 August 1976, when voucher specimens were collected (deposited in OAC, TRT). Specimens of the Kent County stations have been deposited in TRT. Collection data for the Ontario stations are as follows:

P. ciliatifolium var. *muhlenbergii*

Essex Co.: East end of Rickard Street ca. 320 m west

power line, west of Malden Road, Windsor (in Ojibway Prairie Provincial Nature Reserve); open, dry, clay soil beside overgrown roadbed, forming dominant ground cover. W. J. Crins, P. D. Pratt, H. L. Dickson, J. Goltz, and R. J. Pittaway 761. 16 August 1976 (OAC, TRT).

Kent Co.: Zone Township, ca. 1.6 km east of Bothwell, 42°39'N, 81°51'W; open, sandy soil along roadside with *Festuca rubra*. P. M. Catling, A. A. Reznicek, R. Brown, and S. M. McKay. 18 September 1976 (TRT).

P. ciliatifolium var. *stramineum*

Kent Co.: ca. 3.2 km north of Thamesville Station, west side of County Road 26 (to Florence), 42°37'N, 82°0.5'W; dry, sandy soil in open meadow. P. M. Catling, A. A. Reznicek, S. M. McKay, and R. Brown. 18 September 1976 (TRT).

Habitat

At the Essex County site, the species forms a dense ground cover over disturbed clay soil beside a little-used road. It was found in open areas as well as under the partial shade of Pin Oak (*Quercus palustris* Muench.) on an old, unused track nearby. In 1975 and again in 1976, the species was observed in other sites within the Ojibway Prairie Provincial Nature Reserve (known also as the "Windsor Prairie").

The three Ontario stations appear to be quite similar. All are on dry, disturbed, relatively open sites. These areas have long been known for their relict prairie flora (see Rogers 1966), so *P. ciliatifolium* is a consistent addition to the flora of the area. In view of the relatively large extent of this type of habitat in southwestern Ontario, we expect that *P. ciliatifolium* will be found in other localities in that part of the province.

Acknowledgments

The authors express their appreciation to P. M. Catling and A. A. Reznicek of the University of Toronto for supplying valuable comments, data, and verification of the variety of the Essex County specimen. We also appreciate the opportunity of searching the CAN, DAO, OAC, and TRT herbaria, and thank their curators, J. M. Gillett, W. J. Cody, J. F. Alex, and P. M. Catling, respectively.

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Additional Record of the Southern Flying Squirrel from Quebec

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Oxley, D. J. and J. M. Gall. 1978. Additional record of the Southern Flying Squirrel from Quebec. Canadian Field-Naturalist 91(4): 424.

During a study of small mammal movements at Pine Hill, Argenteuil County (45°44'N, 74°29'W), Quebec, four Southern Flying Squirrels, *Glaucomys volans*, were captured in Sherman traps on a 0.9-ha sample plot between 19 and 26 October 1976. The trap-site was a well drained, mature beech-maple (*Acer-Fagus*) forest, which supports the highest populations of *G. volans* in Canada (Banfield 1974). Previous records from Quebec include one specimen collected south of the Ottawa River at Hudson, Vaudeuil County, and four specimens from Gatineau County northwest of Hull (Youngman and Gill 1968).

Three of the squirrels were marked and set free. The

fourth was retained as a specimen in the Vanier College Museum of Natural Science (VCMNS - 301). External measurements in millimetres were 224, 91, 29, 20; weight was 55 g and the testes were abdominal.

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Occurrence of the Green Sunfish (*Lepomis cyanellus*) in the Grand River System

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Kott, Edward and Gregory B. Humphreys. 1977. Occurrence of the Green Sunfish (*Lepomis cyanellus*) in the Grand River system. Canadian Field-Naturalist 91(4): 424-426.

The Green Sunfish (*Lepomis cyanellus*), a species of restricted distribution in Ontario, is reported from the Nith River of the Grand River drainage basin. This species has previously been recorded only from the Thames River drainage system of southwestern Ontario, and in some lakes in Quetico Park in northwestern Ontario. The possibility of species transfer from the Thames system to the Grand system is discussed.

The Green Sunfish (*Lepomis cyanellus*) has a restricted distribution in Ontario. It has previously been found only in several lakes of Quetico Park in northwestern Ontario and in the Thames-Avon River system of southwestern Ontario (Scott and Crossman

1973; Crossman 1976). The present note records the occurrence of this species from a second drainage basin in southwestern Ontario.

During a seining program in the Nith River, a tributary of the Grand River, several specimens of *L.*

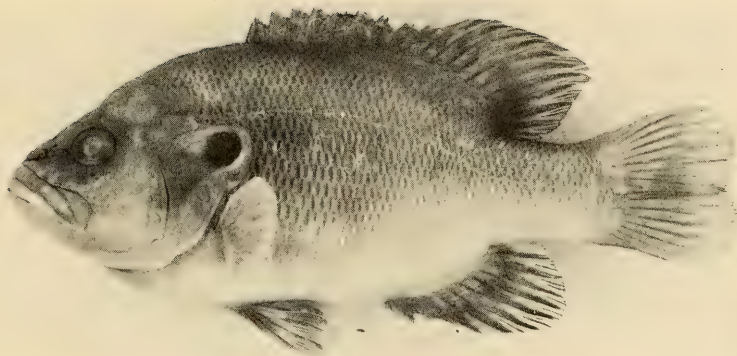


FIGURE 1. Lateral view of the Green Sunfish (*Lepomis cyanellus*), 157 mm total length (128 mm standard length), collected from the Nith River on 10 June 1976.

cyanellus were collected at two locations. One locality was at a washed-out dam just north of Plattsville in Oxford County. On 10 June 1976, eight specimens were collected; on 30 September 1976, 14 individuals were collected. Both collections were from a deep (over 1.9 m maximum depth) oxbow with only a limited connection with the river at the time of collecting. The bottom was muddy.

Specimens from the 10 June collection ranged in size from 44.5 mm to 157 mm total length (37.2 mm to 128 mm standard length). Specimens from the September collection ranged in total length from 31.2 mm to 90 mm (26 mm to 73 mm standard length).

The second location where specimens were collected was at Mornington Centennial Park, just north of Millbank, Perth County, on 25 March 1976. Four fingerlings were caught. The specimens were collected over a flood plain during a period of high water.

The fingerlings ranged in size from 32.9 mm to 37.4 mm total length (25.4 mm to 29 mm standard length).

Adult *L. cyanellus* can be separated from other species of *Lepomis* by the large mouth, large eyes, and relatively short rounded pectoral fins (Figure 1). A dark spot is usually present at the base of the last rays of the dorsal fin, a character it shares with *L. macrochirus*, the bluegill.

Specimens up to about 30 mm in total length, when alive, have a lateral coloration consisting of vertical rows of darkened spots enclosed within a vertically elongated light blue halo. This color pattern largely disappears when a specimen is placed in preservative. Slightly larger specimens do not exhibit the banded coloration of smaller individuals.

No other specimen of *Lepomis* was collected in the Nith River. *Lepomis gibbosus*, the Pumpkinseed,

however, has been recorded from Horner's Creek (= Whiteman's Creek, Mayall 1954), which is the first major tributary of the Grand River south of the Nith River. It flows in a general southeasterly direction as does the Nith. More extensive sampling may reveal the presence of the Pumpkinseed in the Nith River.

The only other centrarchids collected in the Nith River were the Rock Bass (*Ambloplites rupestris*) and the Smallmouth Bass (*Micropterus dolomieu*).

The Green Sunfish has been reported from the Thames-Avon River system, which drains into Lake St. Clair. An examination of the topographic map Stratford 40P/7, edition 5, 1972, published by the Department of Energy, Mines and Resources, Ottawa, shows that Silver Creek, a tributary of the Nith River, is separated from a series of ditches that drain into the Avon River by a distance of 160 m (at 43°24'25" N and 80°51'12" W). On 14 March 1977, a period of high water, the area of separation between the systems was visited. At this time the two systems were connected by a ditch in which the water was about 1.9 m wide and 23 cm deep and the flow was towards the Nith River. Following the ditch south-westward towards the Avon River, the flow in the ditch was still northward towards the Nith River through an extensive low-lying flooded area. This ditch eventually connected with a second ditch whose water flow was southward into the Avon River. At high water, therefore, at least one connection exists between the Avon River and the Nith River. This provides a route for the transfer of the Green Sunfish from the Thames-Avon system to the Grand-Nith system which drains into Lake Erie, and suggests a possible reason for its occurrence in the Nith River.

The specimens of *L. cyanellus* are catalogued in the Wilfrid Laurier Museum as collections WLU 4557,

4696, and 4911 and in the National Museum of Natural Sciences as NMC 77-0610.

We thank Frank Mallory for his help in collecting the specimens. The specimens were verified as *L. cyanellus* by G. C. Gruchy of the National Museum of Natural Sciences, Ottawa.

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Book Reviews

ZOOLOGY

The Red Colobus Monkey

By Thomas T. Struhsaker. 1975. *Wildlife Behavior and Ecology Series*, University of Chicago Press, Chicago. 311 pp., illus. \$25.

In collecting the material for this book, the American primatologist Thomas Struhsaker spent 1593.7 hours observing Red colobus Monkeys in the Kibale Forest Reserve of western Uganda, writing his field notes using carbon paper so that there was little possibility of their loss. He solved the difficulty of working in a dense forest by observing the monkeys from trails marked on the ground in a grid pattern cut along compass bearings, whose intersections occurred either at 50- or 100-m intervals. His book incorporates many of his raw data, making it a more detailed work than the earlier ones in the same series, such as *The Serengeti Lion* by George Schaller and *The Spotted Hyena* by Hans Kruuk, and therefore one less appealing to the layman. In addition to the descriptive text some of the data are incorporated into 58 detailed tables.

Red Colobus Monkeys weigh about 10 kg, with the males somewhat heavier than the females. They are not really red, but have large or small patches of chestnut-colored fur on their trunks, depending on the subspecies. Like most monkeys the Red Colobus lives in social groups that include more females than males. Although they are considered to be arboreal animals, they tend to move rather clumsily in the trees, often jumping from one tree or branch to another with a mighty spread-eagled leap.

An interesting feature of this book is the extensive treatment of vocalizations. Struhsaker used a tape

recorder to tape 16 discrete call types, many of them illustrated by sonagrams. They are described in a number of sections with intriguing titles such as Scream, Sqwack, and Shriek; Wheet; Bark-chist and Chist-bark; Uh!; and Squeals and Gasp of Dying Infant (the infant was found lying neglected on the ground, so Struhsaker carried it home and before it died made extensive recordings of its cries). In this 40-page chapter on vocalizations, as in the others, Struhsaker employs a comparative style that greatly increases the value of his work. After describing the basic sounds made by *Colobus badius tephrosceles* monkeys of Uganda and noting when, by whom, and under what circumstances they were made, he compares their repertoire with that of other races, and his analyses with those of other primate workers. Zoologists studying other species will find these summaries invaluable.

Struhsaker hopes with the publication of this work that more biologists will become interested in the rain forest biome, not only because it is a fascinating, little-studied habitat, but because it is being rapidly destroyed in tropical countries throughout the world. Since it would take 200 or 300 years to replace the largest trees, this biome, once lost, will probably never be regained. Rain forests supply some lumber, but their value as a source of oxygen and of tourism is far greater.

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Reptiles and Amphibians in the Service of Man

By Wilfred T. Neill. 1974. Pegasus, New York. 248 pp.

The sponsors of this book's series (Science and Society) promise at the outset that this biological sciences curriculum study book will be "highly readable," "nontechnical," and instructive. It is.

Neill, noted Florida-based herpetologist and author of the superb *Last of the Ruling Reptiles*, has produced another fine book. Even the title is provocative — surely we do not usually think of reptiles and amphibians as serving man. In this book, Neill is lucid, persuasive, interesting, and often speculative. He frequently argues by anecdote and analogy, and he argues from wide field and laboratory research (see

p. 85). In fact the twenty chapters are laced with personal observations. More important, and for the sake of brevity, he does not just retell the sorry tales of over-exploitation of so many "herptiles" by man ("herps" Neill considers slang, p. 5). Periodically, he debunks myths about his subjects, or reveals that facts about them are often stranger than fiction (e.g., p. 146).

Technical "hardware" and technology are usually well incorporated at appropriate points: in the treatment of developmental biology of the frog and the space program, radio-telemetry, computerized retrieval systems, etc. His sense of herpetofauna and ecological associations is keen, especially when he

discusses such little-studied topics as the effect of controlled burning (chapters III–IV). His writing also has a highly graphic quality, rather like that of Carl Kauffeld and Raymond Ditmars, which creates considerable immediacy. Also, the quite plentiful black-and-white photographs, often simple, may be dramatic (see Figures 29 and 30 illustrating the effects of snake bite).

Some behavioral theories are briefly but intriguingly examined, such as the impulse of hatchling turtles "to fight gravity" (p. 171), and pond specificity (p. 188) of certain amphibians. To a point, an interdisciplinary approach is used, when dealing with cancer and radiation (p. 166), and discoveries regarding sleep (pp. 214–215). Neill suggests directions for herpetological research to take (pp. 75, 168) and problems in such research (p. 117).

The Canadian reader will glean interesting data. For example, on p. 159 we learn that the burrowing "common hog-nosed snake" (no scientific name given) has little or no melanin in its peritoneum, and

on p. 180 that queen snakes are not very difficult to capture.

The book is full of facts without being cluttered. In some places, however, a little more detail would be welcome, as for example, regarding the recent discoveries of new species and races of reptiles and amphibians within the United States (pp. 9–11). Challenging questions are often posed, but sometimes left unanswered. Perhaps on occasion, Neill is too speculative, or too general. More on reptiles and amphibians as indicators of environmental quality and on adaptations to urbanization would be helpful. But specifically, perhaps the worst that can be said of this excellent book is that the style is sometimes abrupt (chapters VIII to IX, "from ecology to enzymes"), and the author too philosophical, as for example when he appears to be anti-women's lib (p. 235).

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A Field Guide to the Birds of West Africa

By W. Serle and G. J. Morel. Illustrated by W. Hartwig. 1977. Collins, London. 351 pp. £5.95.

This latest field guide to birds published by Collins is a case of good intention gone awry. For years, ornithologists and bird-watchers travelling to West Africa have needed a pocketable book to bridge the gap between Bannerman's *The Birds of Tropical West Africa* and Elgood's *Birds of West African Town and Garden*. A *Field Guide to the Birds of West Africa* ought to have filled this gap, but the book has some serious shortcomings which limit its utility.

At first sight *Birds of West Africa* appears to comply with the accepted, modern-day standards set for field guides. It is concise, clearly printed, full of what seems to be informative text, and is illustrated with 48 plates, 28 of them in color. There is a useful introduction to the topography, climate, and vegetation of West Africa at the beginning of the book, and two checklists at the back. One is a checklist of species, the other, a list of scientific and vernacular names in English, Spanish, French, and German. Species in the text are treated under the headings of Identification; Voice; Habitat and Nesting. Notes on allied species are given where applicable. A total of 726 species is given treatment (or mention), and of these, 515 are illustrated, 335 of them in color. The remaining 371 of 1097 West African species are included in the checklist already mentioned.

In using the book, one finds the errors and annoying inconsistencies, which for a field guide, can hardly be tolerated. Consider the illustrations.

Preference is often given to the illustration of species found in one of the authors' own territories (Senegal for Morel, Cameroun for Serle). Thus we find that the Striped Swallow depicted on plate 35 is of the race *maxima*, restricted to Cameroun, whereas the more common and widespread form, *puella*, different in appearance, is not shown. Similarly, the male White-crowned Cliff-chat in Senegal lacks the white crown, but in the remainder of its range, the male possesses it, and we find the dark-crowned form illustrated. One wonders too, when space for illustration is at a premium, why a species such as the House Martin, an uncommon palaearctic winter visitor to West Africa, is illustrated at the expense of common African species such as the Red-rumped and Rufous-chested Swallows.

Most plates show an alarming disregard for scale. The Brubru Shrike on plate 36 is shown to be marginally smaller than the Long-tailed Shrike, yet the former is five-and-a-half inches in length, and the latter, twelve. Such errors of scale can be found on virtually every plate. The proportions of some birds are not correct: the tails of bee-eaters and the heads of owls, to mention only two. The guide also fails I think, to deal adequately with the difficult groups of West birds, notably cisticolas and bulbuls. Many cisticolas have distinct breeding and non-breeding plumages, and these are given full treatment in the text, but the black-and-white plate devoted to this group of birds is unsatisfactory. In the case of bulbuls, I feel the text falls short. The forest pycnonotids are notoriously

difficult to observe, let alone identify. Song is the surest clue in most cases. Yet for two "troublesome" species we are expected to distinguish "bursts of excited throaty babbling" from "bursts of concerted throaty babbling."

Some oddities in nomenclature crop up from time to time, perhaps the most obvious one being the naming of *Pogoniulus chrysoconus* as the Yellow-fronted 'Barbet,' when small capitonids of the genus *Pogoniulus* are generally referred to as 'tinker-birds.' All other pogoniuline barbets in the text are called tinkerbirds.

There is a case of text not matching illustration. A good field mark for the Rock Thrush is the white lower back and rump, and this is properly pointed out

in the text, but not shown in the illustration. Which brings up my final point. In a book credited in the preface to follow the Peterson system of identification, there is not a single use of the very useful field-mark pointers on the plates.

It is a pity that in this era of field guide excellence there appears one which falls short of the mark. But for people in West Africa who wish to venture beyond Elgood's *Birds of West African Town and Garden*, this new guide is just the job.

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Vertebrate Biology

By Robert T. Orr. 1976. Fourth Edition. W. B. Saunders, Philadelphia. 472 pp., illus. \$13.35.

That this is a superior text on vertebrate biology goes without saying; any book that is so popular that it has gone into three new editions since it was first published in 1961 and which has been translated into Spanish must be fulfilling a need for a basic zoology text. In each succeeding edition, the author, Dr. Orr of the California Academy of Sciences, has updated the text, to a limited extent in the sections on anatomy, and to a large degree in the discussions of ecology, ethology, and population dynamics, fields in which new information is being discovered more rapidly.

The first half of the text considers the major classes of vertebrates; the second deals with general topics such as systematics, distribution, reproduction, dormancy, and growth and development. Most, but certainly not all, of the animals discussed live in North

America, and there are a number of sections which will be of special interest to Canadians. These largely concern our arctic fauna, dealing with phenomena such as migration, hibernation, and cyclic fluctuations of some vertebrate populations. Historically Orr considers the effect the Ice Age and attendant glaciation had on the distribution of animals in Canada and on their systematics.

The many black-and-white photographs that illustrate the subject matter of this book are excellent, as are the figures depicting various specific features of animals. Indeed the entire book is a fine one, well worth considering as a text by any professor who teaches a course in vertebrate biology, or by any biologist who needs a reference book on vertebrates.

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BOTANY

Seeds and Fruits of Plants of Eastern Canada and Northeastern United States

By F. H. Montgomery. 1977. University of Toronto Press, Toronto. 232 pp., illus. \$25.00.

Professor Montgomery has done it again! He has produced another invaluable aid to the identification of our flora, which is well keyed and extensively illustrated. Until the appearance of this book botanists and others who wanted to identify a seed, and did not have the rest of the plant, had nowhere to turn and were dependent on the good offices of knowledgeable colleagues, or they had the tedious task of

comparing the specimens to be identified with ones in a herbarium or seed collection. Professor Montgomery's book will simplify the process and make seed and fruit identification available to all who have a modicum of botanical expertise.

The book employs a novel and apparently original key based on gross morphology, and shape in longitudinal and cross sections. The seeds (or the fruits if these are indehiscent and the means of dispersal of the plant) are, for each of the species, keyed, described,

and illustrated. Eleven hundred species, both native and introduced, belonging to 118 families, are included. The illustrations are all black-and-white photographs of the whole seed or fruit, usually shown in several views. They vary considerably in quality but most are at least adequate for their purpose. It is unfortunate that details of surface structure are not shown, for only whole seeds or fruits are illustrated. The use of scanning electron microscope photographs to illustrate these details would have been most useful, for in many species they are diagnostic. Diagrammatic illustrations to show the precise meaning of the major botanical terms used in describing the seeds and fruits removes any possibility of ambiguity, and a full glossary covering almost all the terms used in the account is included. A good index to both English and Latin names enables the user to locate information

rapidly. The book is well produced on a stout semi-gloss paper, and bound so that the pages lie flat wherever the book is opened. It is a business-like production well suited for use on the laboratory bench, with the illustrations appearing alongside the description of each species. The arrangement is taxonomic, permitting ready reference and the comparison of related species. This is a book that will be indispensable to all whose work or interests require the identification of seeds and fruits of plants from eastern North America.

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Carnivorous Plants

By Randall Schwartz. 1974. Praeger (Canadian distributor Burns and MacEachern, Don Mills). 128 pp., illus. \$8.

Here is another popular book on carnivorous plants or, as many people will know them, insectivorous plants. This book is for the amateur, simply written and simply presented with 44 black-and-white photographs of a selection of the more widely known species. The full-page photographs are mostly close-ups of leaves or plants and do help to fill space and make for a more impressive book. One wonders whether it all couldn't have been presented much more attractively in bulletin form.

Carnivorous plants are a fascinating group of plants, often grossly misunderstood, possibly the reason the author has included a seven-page section on science fiction and mythology as they relate to this group of plants. There is also a five-page section of basic information on "How to grow Carnivorous Plants." These plants are not easy to grow in the modern home or apartment. There is, however, an

increasing interest in terrariums, which make for better habitats for these plants that require exacting control of temperature, humidity, and moisture levels.

The photographs are mostly very mundane and unexciting, usually close-ups that do not include a scale. Neither do they allow one to gather any idea of the overall appearance of the plants. As this is an exciting group of plants, and a real challenge to amateur horticulturists, it is unfortunate that the author and his publishers could not have found a more exciting way to illustrate them.

A list of sources is included, of which the author is one. Perhaps we should consider this his catalogue, albeit an expensive one. There are no Canadian sources listed although the Montreal Botanical Gardens is included in a list of places where carnivorous plants can be seen.

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ENVIRONMENT

Physiological Limnology — An approach to the physiology of lake ecosystems

By H. L. Golterman. 1975. Elsevier, New York. xiv + 490 pp., illus. \$51.95.

Lately there has appeared a number of textbooks, G. A. Cole's *Textbook of Limnology* and R. G. Wetzel's *Limnology* to name only two, each seeking to update the subject originally described in the classic

works by Ruttner and Hutchinson. Golterman has chosen to examine the physico-chemical characteristics of aquatic ecosystems and their regulating influences on the biochemistry and physiology of aquatic organisms.

Although I did enjoy reading the book, and some

chapters, such as Chapter 4 on primary production (photosynthesis) in relation to light under natural conditions, will certainly be appreciated by students and aquatic scientists who wish to familiarize themselves with this complex subject, I could not help but feel that the book is already dated even considering its publication date. For example, Chapter 4 does not include the use of liquid scintillation techniques in ^{14}C primary productivity studies. Liquid scintillation spectrometers are more efficient and convenient to use than the counting systems mentioned. No indication is made of the contribution to primary production of lakes by aquatic macrophytes although on page 2 it is noted that the algae are quantitatively the most important of the primary producers (macrophytes, algae, and photosynthetic bacteria), except within the littoral zone of lakes. Chapter 16 looks at bacterial limnology and the work by Wright and Hobbie on microbial utilization of dissolved organic compounds. No reference is made to the studies by Vaccaro, Jannasch and others who used Wright and Hobbie's technique and found that it did not work under some conditions, e.g., usually in oligotrophic waters. Golterman notes that Wright and Hobbie made no correction for the loss of $^{14}\text{CO}_2$ by respiration in their experiments, but he does not cite the 1969 work of Hobbie and Crawford which does. They describe a method to measure the $^{14}\text{CO}_2$ produced and note the importance of it to the kinetic parameters measured in earlier work.

Following the general introduction of Chapter 1, Chapters 2 and 3 cover lakes and their origins and the chemical composition of lakes. This is followed by a series of related chapters on the biological, biochemical, and physico-chemical aspects of aquatic ecosystems. Not until Chapter 18 are lake sediments examined, almost as an afterthought. The importance of sediments to the physiology of lakes is appreciated by limnologists. I do feel that it would better have

followed Chapter 3 so that in the following chapters references could have been made back to it. As it stands, the importance of sediments to the physico-chemistry and biology of the overlying waters would not be conveyed to students. This is not to say that the chapter is not interesting; indeed I found the chapter contained a great deal of interesting information.

One last major criticism remains. In the preface the author notes that previous textbooks have not dealt with the questions that face the water manager, a valid point with which I heartily concur. Golterman then covers water management problems in the last chapter in some 20 pages. Hardly the last word on water management. I would like to have seen this chapter expanded considerably.

In addition to Chapter 4, several other chapters were exceptionally well presented. These include Chapter 13 on algae and their pigments, Chapter 15 on energy and mass transport through food chains, and Chapter 17 on nutrient budgets and eutrophication. Chapter 13 is a good summary of the extensive literature to be found on algal physiology and both Chapters 15 and 17 are concluded with case studies that illustrate the theory discussed.

Golterman intended, as outlined in the preface, that this book should be a first approach to relating the chemical environment with the biochemistry and physiology of the aquatic organisms in a quantitative way. Generally I believe he has accomplished this and that the book will be appreciated by the students for whom it was intended. Indeed, there is much in this book that all aquatic scientists could find useful and informative. It must be stressed that this book is not intended for lay naturalists but for advanced students and scientists.

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Mankind's Future in the Pacific

Edited by R. F. Scagel. 1977. University of British Columbia Press, Vancouver. The plenary and special lectures of the 13th Pacific Science Conference, August 1975. ix + 206 pp. Paper \$6.95.

Dr. Scagel has organized an impressive collection of 13 plenary and special lectures presented at the 13th Pacific Science Congress in August 1975. This interdisciplinary collection, written for a general audience interested in catching up on many important issues now facing man in the Pacific region, represents the work of some of the world's most prolific thinkers.

The first two essays, written by Gerard Piel and Nathan Keyfitz, focus on the population problems in

the Pacific. Piel, who also writes about energy, quotes colleagues like Garrett Hardin, Paul Ehrlich, and Jacob Bronowski to substantiate his analysis of population growth. He does not, however, make any outstanding judgments or propose any solutions to the problems at hand. The essay by Keyfitz is a well-rounded analysis of the complicated variables that interact to shape today's Pacific.

In the next essay, geneticist L. H. Shebeski uses global food equations in a discussion about available food resources in the region. He confines most of his comments to land-based foods. M. Behar, a nutritionist, follows with an examination of the interrela-

tionships of the food and poverty cycles.

Energy, perhaps one of the most controversial topics of the last decade, is reviewed by Lord Ritchie Calder. In his essay, "All Life is Energy," Lord Ritchie examines the sources and alternatives available to society. Technology, the mechanical extension of man's brain, is reviewed by Maurice Strong, who writes . . . "Technology in the hands of industrial man can either enhance or destroy the natural environment resource base; it can either support or undermine the quality of human life in the region." His theme is a very persuasive one in which the need for man to determine his own evolution is stressed. Further, he believes that . . . "the struggle to preserve and enhance the environment of our 'Only One Earth' may be won or lost in the Pacific." This might well be the case in view of the fact that the Pacific region is the largest in the world. Energy and technology are considered in many of the essays intermittently throughout the book.

The social issues confronting man in the region are analyzed by Herman Kahn, a futurologist, and William Epstein, a specialist in arms control and disarmament. Epstein believes that weapons are a form of pollution to the human environment and unless man can ensure his own survival, then there is no point in attempting to improve the ecology. Kahn, who believes that wealth and technology will solve most problems, presents an assortment of visions of the future.

Man's impact on the fauna in the Pacific biota is presented in a scholarly account by Ian McTaggart Cowan, the President of the Pacific Science Association. He examines technological development in relation to the disappearance of many species of fauna

and appeals to man's imagination to save the ecosystems.

J. D. Issacs and P. A. Larkin write about a much neglected subject, science policy. Both are aquatic biologists and both review the philosophy behind decision-making and policy formulation in the region. Issacs is unhappy with the present system because it represents the contributions of too few countries. Larkin feels that man's technological development is progressing more rapidly than is socially desirable, and that society is incapable of developing a competent policy under such circumstances.

The last essay in the book is by Thor Heyerdahl, a well known anthropologist and archaeologist, whose adventures in primitive crafts have lead him to alter many theories of early navigation. He writes about primitive navigation and simultaneously reveals an interesting and factual story about native cultures.

I have refrained from making comments about Frank Fenner's essay, "Options for Man's Future: A Biologists View," because it deserves special mention. Essentially, it is a capsule summary of the major issues surrounding man in the Pacific, and in fact, the world. But more than that, the essay is a well documented account, with illustrative graphs and charts, of man's changing position on earth in relation to the environment in which he lives. It is recommended that this essay be read before any of the others.

This book has a conscience. It is an excellent addition to the continuing saga of world dynamics.

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Erosion of Land in Northwestern Alberta — Report and recommendations

By W. R. Trost (Chairman). 1976. Alberta Environment Conservation Authority, Edmonton. 73 pp. Free.

The report on *Erosion of Land in Northwestern Alberta* by the Alberta Environment Authority was instigated as a result of the interest generated by the Peace River Regional Agricultural Service Board (1974), the Provincial Conference of Agricultural Service Boards (February 1975), and to the resultant public petition of 200 signatures. The area which the report encompasses is west and north from the city of Edmonton to the provincial boundaries with British Columbia and the Northwest Territories, or roughly an area of 100 000 square miles.

In this region two areas were under study: the Peace River District and Lesser Slave Lake Watershed. It was felt that each had its inherent erosion control problems. Recommendations on erosion control were

to be made for each respective district.

The region had two major periods of settlement, the first of which was at the time of the completion of a railroad to the area in 1916. The second settlement was at the advent of the Second World War and the completion of the Alaskan Highway. The first exploiters of the land were agriculturalists, but the discovery of varied mineral resources led to the diversification of land utilization.

It became apparent to the early settlers that an erosion problem existed. It was found that the causes of some of the problem were due to the adaptation of an inappropriate Great Plains farming technology to Northwestern Alberta. Government and public interest was stimulated to examine ways in which they could, along with the educational institutions and land managers, pool their collective resources to accom-

plish (1) solutions to the problem of land reclamation due to past erosion difficulties, and (2) the prevention of future losses due to agricultural or other breakings. Alberta will have to live with past management decisions but this report is indicative of a new trend for making management decisions on new frontiers. The basic premise underlying the report is that every frontier is characteristic in nature of geological, hydrological, and vegetational properties. Management decisions affecting the utilization of any one of these resources will have to be considered in the context of each individual property as it affects the total situation. A number of government and private institutions have jurisdiction over each property which affects the outcome of land use. Therefore it is imperative that land management decisions be integrated with each jurisdiction prior to the establishment of a land policy. This is to be done with a referral system situated in government to deal with the total problem through consultation with other departments and agencies affected. All relevant factors can thus be considered and integrated solutions can be achieved.

Northwestern Alberta has 5 million acres presently being farmed. The potential exists to increase farm acreage by 10–15 million acres in addition to a potential of 50 million acres for forestry production. The area is, in effect, a new frontier. The government realizes the fragility of the region and in order to ensure its continued productivity and minimize erosion losses, there is an increased interest in developing policies for proper resource and land utilization.

Although the subject matter of the work may not be

of interest to all, the manner in which the government proceeded to do the report is indicative of a new era of decision-making. The report takes into consideration the needs of the land manager, the diversity of government jurisdictions, and the characteristics of the region under scrutiny. All facets have an input into the decision-making process.

The Albertan Department of Transport's referral system was recommended as a model for the Department of Agriculture and others in soil surface operations. However, it was stated in passing in the report. It would have been useful to have included a practical example of how the system works.

The work is rather choppy at times but this is owing to the large number of briefs presented to the Authority. To try to represent all points of view in 70 pages is at best a monumental task.

An important underlying principle of the report was that of public input. In this writer's opinion the work was weighted in the realm of government and professional testimony. Perhaps the situation would have been better clarified had the report included a model of government-professional-public interaction in the decision-making process so that the reader could determine how a balance could be struck.

Overall I believe the work will be of interest and of value to all persons involved in land management and planning.

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NEW TITLES

Zoology

African ungulates. A comparative review of their ethology and behavioral ecology. 1977. By Walter Leuthold. Volume 8. Zoophysiology and Ecology. Springer-Verlag, New York. xiv + 308 pp., illus. \$31.70.

The Audubon Society book of wild birds. 1976. By Les Line and Franklin Russell. Abrams, New York. 292 pp., illus. \$35.

The biology of sticklebacks. 1976. By R. J. Wootton. Academic, New York. x + 385 pp., illus. \$29.50.

The book of turtles. 1977. By R. E. Nicholls. Running Press, Philadelphia. 152 pp., illus. Paper \$4.95.

Collected papers in avian paleontology honoring the 90th birthday of Alexander Wetmore. 1976. Edited by Storrs L. Olson. Smithsonian Contributions to Paleobiology Number 27. Smithsonian Institution Press, Washington. xxvi + 212 pp., illus.

Bears. Their biology and management. 1976. Edited by M. R. Pelton, J. W. Lentfer, and G. E. Folk. Papers from a conference, Binghamton, New York, June 1974 and a congress, Moscow, June 1974. IUCN Publications New Series Number 40. International Union for Conservation of Nature and Natural Resources, Morges, Switzerland. 468 pp., illus. Paper \$12.

Eagles of the world. 1977. By Leslie Brown. Universe, New York. 224 pp., illus. \$12.50.

†**Handbuch der Voegel Mitteleuropas.** Band 7. Charadriiformes (2. Teil). 1977. Edited by U. N. G. von Blotzheim, K. M. Bauer, and E. Bezzel. Akademische, Wiesbaden. 893 pp., illus.

†**How reptiles and amphibians live.** 1977. By A. C. Echternacht. Volume 6 of *How animals live*. Edited by P. Hutchinson. Elsevier Phaidon, Oxford. (Canadian distri-

- butor Burns and MacEachern, Don Mills). 142 pp., illus. \$12.50.
- An illustrated key to freshwater and soil amoebae with notes on cultivation and ecology.** 1976. By F. C. Page. Scientific Publication Number 34. Freshwater Biological Association, Ambleside, England. 156 pp. Paper £2.50.
- Lambert's birds of garden and woodland.** 1977. By A. Mitchell. Paintings by T. Lambert. Scribner, New York. 128 pp. \$12.50.
- Little mammals of the Pacific Northwest.** 1977. By Ellen Krilzman, Douglas, Douglas, David, and Charles, Vancouver. 128 pp., illus. Paper \$5.95.
- Lost wild worlds: the story of extinct and vanishing wildlife of the eastern hemisphere.** 1976. By R. M. McClung. Morrow, New York. 288 pp., illus. \$8.95.
- Murex shells of the world.** An illustrated guide to the Muricidae. 1976. By G. E. Radwin and A. D'Attilio. Color photographs by D. K. Mulliner. Stanford University Press, Stanford. xii + 284 pp. + plates. \$35.
- The polychaete worms.** Definitions and keys to the orders, families, and genera. 1977. By K. Fauchald. Natural History Museum of Los Angeles County, Los Angeles. x + 188 pp., illus. Paper \$7.
- †**Proceedings of the 1975 predator symposium.** 1977. Edited by Robert L. Phillips and Charles Jonkel. Montana Forest and Conservation Experimental Station, University of Montana, Missoula. ix + 268 pp., illus. Paper \$4.
- Reptile ecology.** 1976. By Harold Heatwole. Australian Ecology Series. University of Queensland Press, New York. xviii + 178 pp., illus. Cloth \$20; paper \$9.95.
- ***Rocky Mountain wildlife.** Ecology, behavior, identification, distribution. 1976. By Don Blood, Tom W. Hall, and Susan I. Baumgarten. Hancock House, Saanichton, British Columbia. 132 pp., illus.
- †**Running, walking and jumping.** The science of locomotion. 1977. By Anne Innis Dagg. Wykeham, London. x + 143 pp., illus. Paper £3.25; cloth £5.75.
- Shells and shores of Texas.** 1977. By Jean Andrews. University of Texas Press, Austin. xx + 366 pp., illus. \$19.95.
- ***Snakes — a natural history.** 1977. By Parker and Grandison. Cornell University Press, Ithaca. Cloth \$8.95; paper \$3.95.
- Theories of populations in biological communities.** 1977. By F. B. Christiansen and T. M. Fenchel. Ecological Studies Volume 20. Springer-Verlag, New York. x + 144 pp., illus. \$27.30.
- Monographs in Experimental Biology Number 19.** Cambridge University Press, New York. viii + 110 pp., illus. \$12.50.
- The flora of Manitoulin Island and the adjacent islands of Lake Huron, Georgian Bay and the North Channel.** 1977. By J. K. Morton. University of Waterloo Biology Series Number 15, Waterloo. 62 pp. \$4.50.
- Fossil algae.** Recent results and developments. 1977. Edited by Erik Fluegel. Papers from a symposium, Erlanger, West Germany, October 1975. Springer-Verlag, New York. xiv + 376 pp., illus. \$36.10.
- †**Genera of the eastern plants.** A guide to the genera of native and commonly introduced ferns and seed plants of eastern North America from the Atlantic to the Great Plains from Key West–Southern Texas into the Arctic. 1977. By Wade T. Batson. 3rd edition. Wiley, New York, Toronto. 203 pp., illus. Paper \$5.50.
- Hortus third.** A concise dictionary of plants cultivated in the United States and Canada. 1977. Initially compiled by L. H. and E. Z. Bailey. Revised and expanded by the staff of the Liberty Hyde Bailey Hortorium. MacMillan, New York. 1290 pp. \$99.50.
- Northland wildflowers.** A guide for the Minnesota region. 1977. By J. B. Moyle and E. W. Moyle. University of Minnesota Press, Minneapolis. x + 236 pp., illus. \$12.95.
- A plant geography of Alberta.** An interpretation based on the 1965 vegetation map. 1976. By Margaret E. E. North. Studies in Geography Monograph 2. University of Alberta Department of Geography, Edmonton. xiv + 148 pp. + map. Paper \$5.
- Seaweeds.** A color-coded, illustrated guide to common marine plants of the east coast of the United States. 1977. By C. J. Hillson. Pennsylvania State University Press, University Park. x + 194 pp. Cloth \$10; paper \$6.95.
- Who named the daisy? Who named the rose?** A roving dictionary of North American wild flowers. 1977. By Mary Durant. Drawings by Eleanor Cooney. Dodd, Mead, New York. x + 214 pp. \$7.95.
- Wildflowers of Manning Park.** 1976. By J. L. Underhill and C. C. Chuang. British Columbia Museum, and British Columbia Provincial Park, Victoria. 144 pp.
- Environment**
- America's great outdoors.** The story of the eternal romance between man and nature. 1977. Edited by L. J. Bashline and D. Saults. Ferguson, Chicago. xvi + 368 pp., illus. + plates. \$24.95.
- Conservation of resources.** 1977. Papers from a symposium, Glasgow, April 1976. Special Publication Number 27. Chemical Society, London. x + 246 pp., illus. Paper \$12.
- Ecology and the politics of scarcity.** Prologue to a political
- Botany**
- Defense mechanisms of plants.** 1977. By B. J. Deverall.

theory of the steady state. 1977. By William Ophuls. Freeman, San Francisco. xiv + 304 pp. Cloth \$12.95; paper \$6.95.

Ecology out of joint. New environments and why they happen. 1977. By L. J. and M. Milne. Scribner, New York. xii + 304 pp., illus. \$8.95.

Ecosystem research in South America. 1977. Edited by Paul Muller. Biogeographica Volume 8. Junk, The Hague. vi + 152 pp., illus. Dfl. 45.

Evolution and ecology. Essays on social transformation. 1977. Edited by J. H. Steward, J. C. Steward, and R. F. Murphy. University of Illinois Press, Urbana. x + 406 pp. \$12.95.

Marine ecology. Selected readings. 1976. Edited by J. S. Cobb and M. M. Harlin. University Park Press, Baltimore. xii + 546 pp., illus. Paper \$16.50.

Muskeg and the northern environment in Canada. 1977. Edited by N. W. Radforth and C. O. Brawner. University of Toronto Press, Toronto. 399 pp., illus. \$35.

†**A nature conservation review.** The selection of biological sites of national importance to nature conservation in Britain. Volumes I and II. 1977. Edited by Derek Ratcliffe. Cambridge University Press, London, New York. xvi + 401 pp. + maps, viii + 319 pp. \$69.50, \$49.50.

Outdoors Canada. A unique and practical guide to our wilderness and wildlife. 1977. Edited by Douglas R. Long. Canadian Automobile Association and Reader's Digest, Montreal. 384 pp., illus. \$21.77 (to members).

Seagrass ecosystems. A scientific perspective. 1977. Edited by C. P. McRoy and C. Helerich. Papers from a workshop, Leiden, Netherlands, October 1973. Marine Science Volume 4. Dekker, New York. xii + 314 pp., illus. \$29.75.

The swamp. 1976. By Bill Thomas. Norton, New York. 223 pp., illus. \$24.95.

Underwater life: the world you never see. 1976. By P. Parks. Rand McNally, Chicago. 128 pp., illus. \$9.95.

Wet coastal ecosystems. 1977. Edited by V. J. Chapman. Ecosystems of the world. Volume I. Elsevier, New York. xii + 428 pp., illus. \$49.95.

Other

†**The aquatic explorers:** a history of the Fisheries Research Board of Canada. 1977. By Kenneth Johnstone. University of Toronto Press, Toronto. xv + 342 pp., illus. \$20.

The collected papers of Charles Darwin. 1977. Edited by P. H. Barrett. University of Chicago Press, Chicago. 2 volumes. xviii + 278 pp., illus. and viii + 326 pp. \$20 each.

Field guide to snow crystals. 1977. By E. R. LaChapelle. Douglas, Douglas, David, and Charles, Vancouver. 104 pp., illus. Paper \$4.95.

Interpreting the earth. 1977. By Robert R. Compton. Harcourt Brace Javanovich, New York. xx + 554 pp., illus. \$14.95.

Natural resources of British Columbia and the Yukon Territory. 1977. By Mary L. Barker. Douglas, Douglas, David, and Charles, Vancouver. 166 pp., illus. \$13.95.

Planet earth: encyclopedia of geology. 1977. Edited by A. Hallam. Plays (Canadian distributor Burns and MacEachern, Toronto). 320 pp., illus. \$24.

†**Point Pelee.** Canada's deep south. 1977. By Darryl Stewart. Burns and MacEachern, Toronto. 112 pp., illus. Paper \$5.95.

†**Science Council of Canada study on population, technology and resources.** Perceptions 4, people and agricultural land. 1977. By Charles Beaubien and Ruth Tabacnik. Science Council of Canada, Ottawa. 137 pp., illus. Canada \$4; elsewhere \$4.80.

Soils of the polar landscapes. 1977. By John C. F. Tedrow. Rutgers University Press, New Brunswick, New Jersey. xxvi + 638 pp., illus. \$60.

†**Weather almanac.** A reference guide to weather, climate and air quality in the United States and its key cities comprising statistics, principles and terminology. 1977. Edited by J. A. Ruffner and F. E. Blair. 2nd edition. Gales, Detroit. 728 pp. \$25.

†available for review

*assigned for review

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